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EFFECT OF FOOD WASTE GRINDERS ON SEPTIC TANK SYSTEMS. REPORT TO THE FEDERAL HOUSING ADMINISTRATION

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Cincinnati, Ohio

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Report of a Study Sponsored by the

Federal Housing Administration

to

Determine the Effect of

FOOD WASTE GRINDERS

on Septic Tank Systems

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119

CONCLUSIONS

The following conclusions apply to individual household sewage disposal systems. The conclusions are based on studies conducted in several areas of the United States covering a wide range of climate, soil, and control and construction practices.

1. The addition of ground food wastes to septic tank systems resulted in a significant increase in the rate of accumulation of scum and sludge.

2. When adjusted for the effect of age and capacity, septic tanks that received ground food wastes accumulated scum plus sludge at a rate about 37 percent greater than septic tanks that did not receive ground food wastes.

3. The table of minimum recommended liquid capacities for septic tanks in the Manual of Septic Tank Practice (Table 4, page 22) or the FHA Minimum Property Standards (Table 11-3, page 220) can be used for homes equipped with food waste grinders.

4. Under comparable conditions of amount of soil absorption area provided, age, and home occupancy, systems receiving ground food wastes showed a higher rate of failure.

5. Septic tank-soil absorption systems that received ground food wastes used about 25 percent greater absorption area in order to obtain comparable performance to systems that did not receive ground food wastes.

6. The design tables for soil absorption systems in the Manual of Septic Tank Practice (Table 1, page 6) or in the FHA Minimum Property Standards (Table 11-5, page 221) can be used to determine the design bottom area for soil absorption systems that are to receive ground food wastes.

7. The addition of ground food wastes to septic tank systems had no influence on the start-up of digestion in septic tanks nor was there any evidence that the process was impeded.

8. In general, properly designed and maintained septic tank-soil absorption systems can handle the additional loadings due to grinders through the provision of more tank capacity and increased leaching area.

CONTENTS

Section — Page No.

STUDY OF THE EFFECT OF FOOD WASTE GRINDERS ON SEPTIC TANK SYSTEMS

CONCLUSIONS ii

BACKGROUND 1

METHOD AND PROCEDURE 3

SUMMARY OF RESULTS 5
- Scum and Sludge Accumulations 5
- Soil Absorption Systems 7
  - Gross Performance 7
  - Survival Curves 11
  - Soil Area Used 13
  - Most Economical Design 15
- "Starting" of Digestion 19

ACKNOWLEDGMENTS 20

REFERENCES 22

APPENDIX

DATA FROM OTHER FHA STUDIES

GENERAL INFORMATION 1
- Gross Performance 1
- Survival Curves 4
- Soil Area Used 6
  - Maricopa County, Arizona 6
- Scum and Sludge Accumulations 9
  - Maricopa County, Arizona 9
  - Duval County, Florida 12

WYANDOTTE COUNTY, KANSAS

GENERAL INFORMATION 16
- Climate 16
- Soils and Topography 16
- Health Department Organization and Septic Tank Practice 18

Section

Page No.

RESULTS OF FIELD STUDIES 19
Subdivision Descriptions 19
Soils Descriptions 21
Construction and Loading 22
Other Performance Affecting Factors 23
Gross Performance 25
Survival Curves 27
Soil Area Used 27
Scum and Sludge Accumulations 30

POLK COUNTY, IOWA

GENERAL INFORMATION 33
Climate 33
Soils and Topography 33
Health Department Organization and Septic Tank Practice 35

RESULTS OF FIELD STUDIES 37
Survey Area Descriptions 37
Soils Descriptions 38
Construction and Loading 39
Other Performance Affecting Factors 40
Gross Performance 42
Survival Curves 43
Soil Area Used 45
Scum and Sludge Accumulations 47

TARRANT COUNTY, TEXAS

GENERAL INFORMATION 50
Climate 50
Soils and Topography 52
Health Department Organization and Septic Tank Practice 52

RESULTS OF FIELD STUDIES 54
Subdivision Descriptions 54
Soils Descriptions 55
Construction and Loading 56
Other Performance Affecting Factors 57
Gross Performance 59
Survival Curves 61
Soil Area Used 62
Scum and Sludge Accumulations 62

Section | Page No.

DALLAS COUNTY, TEXAS

GENERAL INFORMATION 63
Climate 63
Soils and Topography 63
Health Department Organization and Septic Tank Practice 65

RESULTS OF FIELD STUDIES 67
Subdivision Descriptions 67
Soils Descriptions 68
Construction and Loading 69
Other Performance Affecting Factors 70
Gross Performance 72
Survival Curves 73
Soil Area Used 75
Scum and Sludge Accumulations 80

DATA FORMS

FOOD WASTE GRINDER - PRELIMINARY SURVEY 83

FOOD WASTE GRINDER - DETAIL SURVEY 87

BACKGROUND

Since their introduction in the mid-1940's the use of food waste grinders has steadily increased, and in all probability this trend will continue. In January 1961 it was estimated[1] that about 11 percent of all electrically wired homes in the United States were equipped with food waste grinders. This represents almost 5½ million homes. Annual sales of grinders have increased from 175 thousand in 1948 to about 760 thousand in 1960.

A survey of owners by one manufacturer[2] indicated that about 13 percent of the disposers bought from 1944 through 1960 were installed in homes served by individual sewage disposal systems. This value varied from about 10 percent in the New England States to about 20 percent in the Western States.

Professional opinion concerning the effect of food waste grinders on septic tank systems has been divided. One group believes that grinders cause trouble even with increased capacity of septic tanks and soil absorption systems, and recommends against their use. Another group believes that grinders do not cause trouble and that to require an increase in system capacity is an unwarranted additional expense.

Sewage from homes equipped with food waste grinders may be expected to have a substantially higher solids load than sewage from homes without the appliance. Limited laboratory and field investigations[3] indicated that in order to obtain comparable performance to systems without food waste grinders, systems with a grinder should have increased capacities. This led

to some recommended design criteria[4][5] including a 50 percent increase in septic tank capacity and a 20 percent increase in absorption area capacity. Because of differences in opinion and the economic factors involved, the need for increased capacities deserved a more critical evaluation.

The objectives of this study have been threefold: (1) determination of the effect of ground food wastes on the rates of accumulation of scum and sludge, (2) determination of the effect of ground food wastes on the rate of failure of soil absorption systems, and (3) determination of the effect of ground food wastes on the "starting" of digestion in the septic tank.

METHOD AND PROCEDURE

The methods and procedures followed in these studies were developed during an investigation of seepage beds and are described in detail in a previous report.(6)

All investigations were conducted in the field to compare the performance of systems with food waste grinders to systems without food waste grinders under actual-use conditions. Performance of soil absorption systems was judged on the length of time of satisfactory service as related to construction and loading factors, and on the rate of use of soil absorption area. Septic tank performance was judged on the rate of accumulation of scum and sludge.

Locations selected for study were Polk County, Iowa; Wyandotte County, Kansas; and Tarrant and Dallas Counties, Texas. These areas include a wide range of climates and soil types. A summary of activities in the four areas is shown in Table 1.

Table 1

Summary of Activities

County & State	Date		Observations	
	From	To	General	Detailed
Wyandotte, Kansas	May 1, 1959	Aug. 26, 1959	164	24
Polk, Iowa	May 5, 1959	Oct. 23, 1959	380	32
Tarrant, Texas	Feb. 8, 1959	May 9, 1959	125	4
Dallas, Texas	Apr. 13, 1959 Nov. 5, 1959	Aug. 29, 1959 May 23, 1960	495	43

Pertinent information was also extracted from other current FHA studies and from a field study conducted for the FHA in Duval County, Florida in 1951.

Selection of housing subdivision study areas was made after consideration of soil conditions, number of food waste grinder equipped homes, ages of homes, and the amount of preliminary information that could be obtained from health department and building department records. Subdivision areas were selected which contained a fairly equal distribution of homes with and without food waste grinders. Telephone canvassing of promising locations proved very successful for locating the final study areas.

In each area selected two separate types of investigations were conducted. General surveys were made at a large group of residences to determine actual performance; detailed examinations were made at selected individual homes to obtain accurate measurements of soil absorption system and septic tank system construction, loading, and performance details. The detailed study cases were selected from the previously completed general survey cases. Only those cases in which the septic tank had never been cleaned or where an accurate cleaning date could be established were used for detailed studies. The information sheets shown in the Appendix were completed for each home.

SUMMARY OF RESULTS

Scum and Sludge Accumulations.

A summary of the gross rates of scum and sludge accumulations in each of the five study areas and weighted averages for the five areas combined is given in Table 2. Detailed data for each area are given in the Appendix. The data for Duval County, Florida were obtained during a previous series of studies in 1951. The data for Maricopa County, Arizona were obtained during the seepage pit study. All other data were obtained during the study of the effects of food waste grinders on septic tank systems.

Table 2

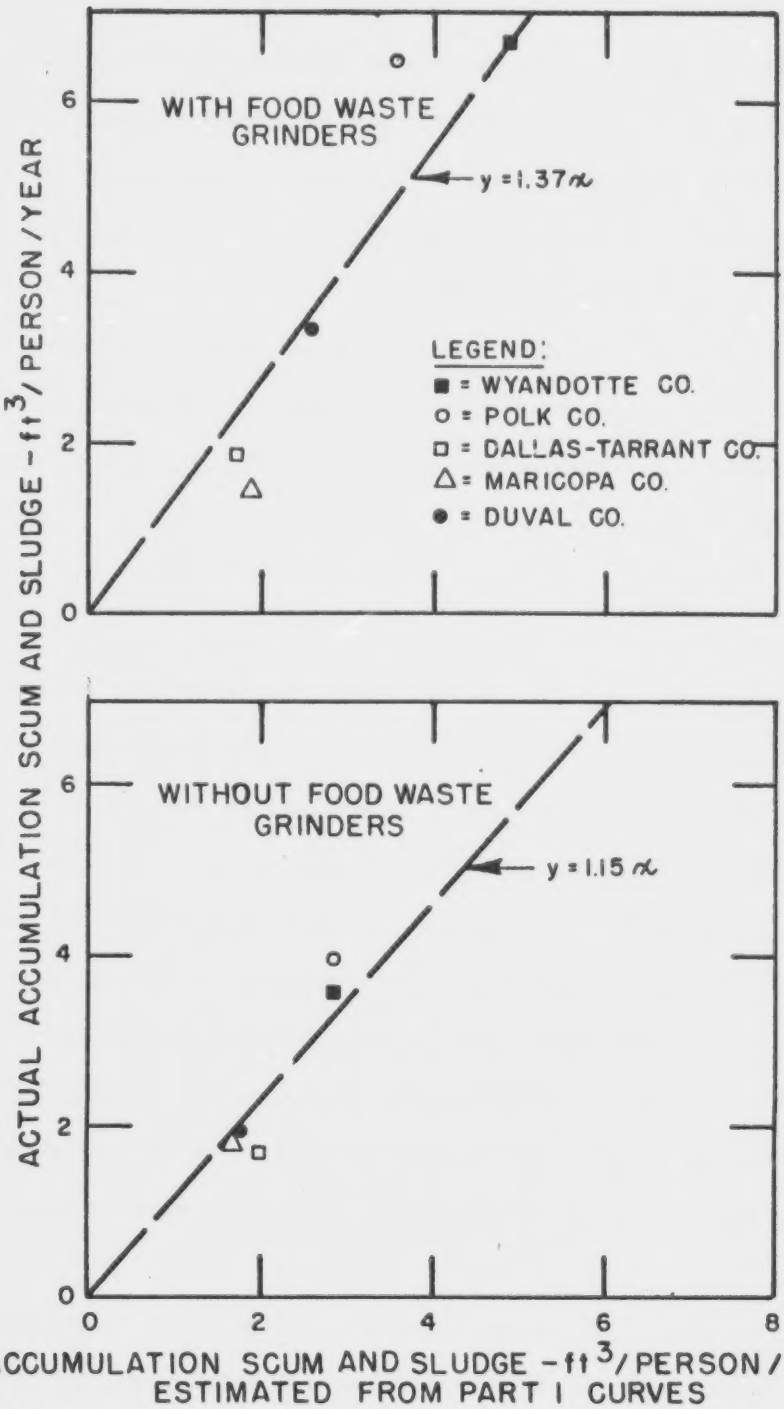
Summary of Scum and Sludge Accumulation Rates

County and State	Mean Accumulation Rate, Ft^3/Person/Year					
	Scum		Sludge		Scum and Sludge	
	With	Without	With	Without	With	Without
Wyandotte, Kansas	0.40	0.50	6.29	3.11*	6.70	3.61
Polk, Iowa	1.41	0.80*	4.73	3.18*	6.14	3.98*
Dallas and Tarrant, Texas	0.86	0.59*	1.01	1.11	1.87	1.70
Maricopa, Arizona	0.86	0.97	0.88	0.85	1.74	1.82
Duval, Florida	1.51	0.49*	1.82	1.39	3.33	1.88*
Combined	1.07	0.71**	2.81	1.67**	3.73	2.39**

*Indicates difference is significant at the 95 percent confidence level.
**Indicates difference is significant at the 99 percent confidence level.

The differences in accumulation rates between with and without food waste grinder systems vary from area to area, ranging from no significant difference in the combined scum and sludge in Maricopa and Dallas-Tarrant Counties to an 85 percent greater accumulation in the food waste grinder tanks in Wyandotte County. Considering the combined data, accumulation rates are significantly higher in the food waste grinder systems for all categories of solids: 50 percent, 68 percent, and 56 percent greater for scum, sludge, and scum and sludge, respectively.

Part of the variation in accumulations is due to the fact that a variety of septic tank capacities and times in service are involved. A previous study[7] showed that higher rates of accumulation are to be expected in the larger tanks and younger systems. Curves were presented relating the rate of accumulation of scum and sludge to these two factors. The septic tanks concerned served homes where food waste grinders were not used. From these curves the accumulation rates of scum plus sludge for tanks of the same capacities and ages as those in the present study have been estimated for each area. These rates are shown graphically in Figure 1. The mean sludge and scum accumulation rate for the food waste grinder tanks in the present study is about 37 percent greater than tanks of the same capacity and age would have accumulated under the previous non-food waste grinder conditions. The non-food waste grinder tanks in the present study accumulated solids at about a 15 percent greater rate than the same capacity and age tanks would have under the previous conditions.



COMPARISON OF SCUM AND SLUDGE ACCUMULATIONS PART I STUDY AND PRESENT STUDY

FIGURE 1

In order to compare scum and sludge accumulation rates statistically, the present study data may be corrected and expressed in terms of relative accumulation for a "standard" capacity and age. A summary of the accumulation data corrected to a septic tank capacity of 150 gallons per capita and an age of 7 years is shown in Table 3.

On the basis of "standard" conditions of capacity and age, the food waste grinder tanks accumulated scum and sludge at a rate about 12 percent greater than the non-food waste grinder tanks. The increase is significant at the 95 percent confidence level.

Soil Absorption Systems.

Gross Performance. The over-all performance of soil absorption systems with and without food waste grinders in the study areas in eight counties in seven different states is summarized in Table 4.

Many factors other than the use of food waste grinders may affect the performance of septic tank systems. A bias produced by any one or a combination of factors which would favor one group of systems over the other could produce misleading results concerning the effect of food waste grinders. A comparison of factors which have an obvious influence on performance and may produce such a bias is also shown in the table. Detailed comparison of the factors for each individual area is shown in the Appendix.

Other possible performance affecting factors such as construction practice, climate, type and adequacy of control procedures, and inspection were maintained comparable between groups of systems within any one county jurisdiction.

Table 3

Scum and Sludge Accumulations
Expressed as Relative Rates

County and State	Age, Yrs.	Capacity, Gals./Person	Accumulation Rate of Scum and Sludge, Ft^3/Person/Yr.		Ratio Corrected Acc. With / Corrected Acc. Without
			Actual	Corrected*	
With Food Waste Grinders					
Wyandotte, Kan.	2.38	301	6.70	2.70	1.16
Polk, Iowa	3.25	309	6.14	2.90	1.07
Dallas and Tarrant, Texas	4.85	170	1.87	1.67	1.14
Maricopa, Ariz.	4.90	191	1.74	1.46	0.98
Duval, Florida	3.22	256	3.33	1.94	1.25
Mean	3.72	245	3.73	2.13	1.12**
Without Food Waste Grinders					
Wyandotte, Kan.	2.86	215	3.61	2.33	
Polk, Iowa	3.73	234	3.98	2.70	
Dallas and Tarrant, Texas	5.60	201	1.70	1.46	
Maricopa, Ariz.	5.00	206	1.82	1.49	
Duval, Florida	3.67	165	1.88	1.55	
Mean	4.17	204	2.39	1.91	

*Corrected to a "standard" age of 7 years and a "standard" capacity of 150 gals./person.
**Significantly different from 1.0 at the 95 percent level.

Table 4

Summary of Performance and Distribution of Performance Affecting Factors in With and Without Food Waste Grinder Systems in Eight Counties

County and State	Performance Affecting Factors*								Performance**
	Age	Persons	Laundry Use	Abs. Area Provided	Septic Tank Capacity	Alteration to Topography	Ground Slope	Soil Type	
Maricopa, Arizona	0	0	0	0	0	0	0	0	0
San Diego, Calif.	+	-	0	-	+	0	0	+	+
Mecklenburg, No. Car.	-	0	0	0	0	0	0	0	0
Kent, Michigan	+	0	0	+	0	0	0	0	0
Wyandotte, Kansas	+	0	0	0	0	-	0	0	-
Polk, Iowa	+	0	0	+	+	0	0	0	0
Tarrant, Texas	0	0	0	+	+	0	0	0	0
Dallas, Texas	+	-	0	+	+	0	0	0	0
Combined***	+	-	0	+	+	0	0	0	0

*Key: 0, No significant difference in the distribution of the performance affecting factor between with and without food waste grinder systems.
+, The distribution of the performance affecting factor favors better performance of food waste grinder systems.
-, The distribution of the performance affecting factor favors poorer performance of food waste grinder systems.

**Key: 0, No difference in performance between with and without food waste grinder systems.
+, Better performance shown by food waste grinder systems.
-, Poorer performance shown by food waste grinder systems.

***Data for Wyandotte, Dallas, Tarrant, and Polk Counties combined.

The results, presented in Table 4, are not conclusive but they do indicate some trends. In San Diego County the seepage pit systems at homes with food waste grinders showed better performance than those without food waste grinders; however, the food waste grinder systems were much younger and were installed in better soils. They did have a somewhat greater person loading and less absorption area.

In Maricopa County there were no significant biasing factors favoring either group of systems, and there was no difference in performance. In Mecklenburg County the age factor in the food waste grinder group favored poorer performance, but none of the other performance affecting factors were different. There was no difference in actual performance of the two groups of systems.

In Dallas, Kent, and Polk Counties there was also no difference in performance between the two groups; however, significantly greater absorption areas were provided and systems were significantly younger in the food waste grinder group. In Tarrant County system performance was comparable but greater absorption areas were found in the food waste grinder group. It would appear that greater soil capacity and/or the younger ages resulted in comparable performance.

In Wyandotte County where equivalent areas were provided for each type of system, the food waste grinder systems had a significantly higher failure rate even though age favored better performance of these systems. More of the food waste grinder systems were found in cut or fill.

The combined data for four areas investigated specifically for the food waste grinder study, Polk, Wyandotte, Tarrant, and Dallas Counties, are shown in the last line of Table 4. In this combined data the factors of age,

area provided, and septic tank capacity favor the better performance of food waste grinder systems, but the actual performance is not significantly different. Apparently the increased septic tank capacities and absorption areas for food waste grinder systems are needed to obtain performance comparable to non-food waste grinder systems.

Survival Curves. Mortality-type survival curves provide convenient means for comparing the performance of the two groups of systems over comparable age spans. They interrelate the age at which each failure occurs with the total failures in the time span of the observation. In this respect they can be more meaningful than the gross performance comparison.

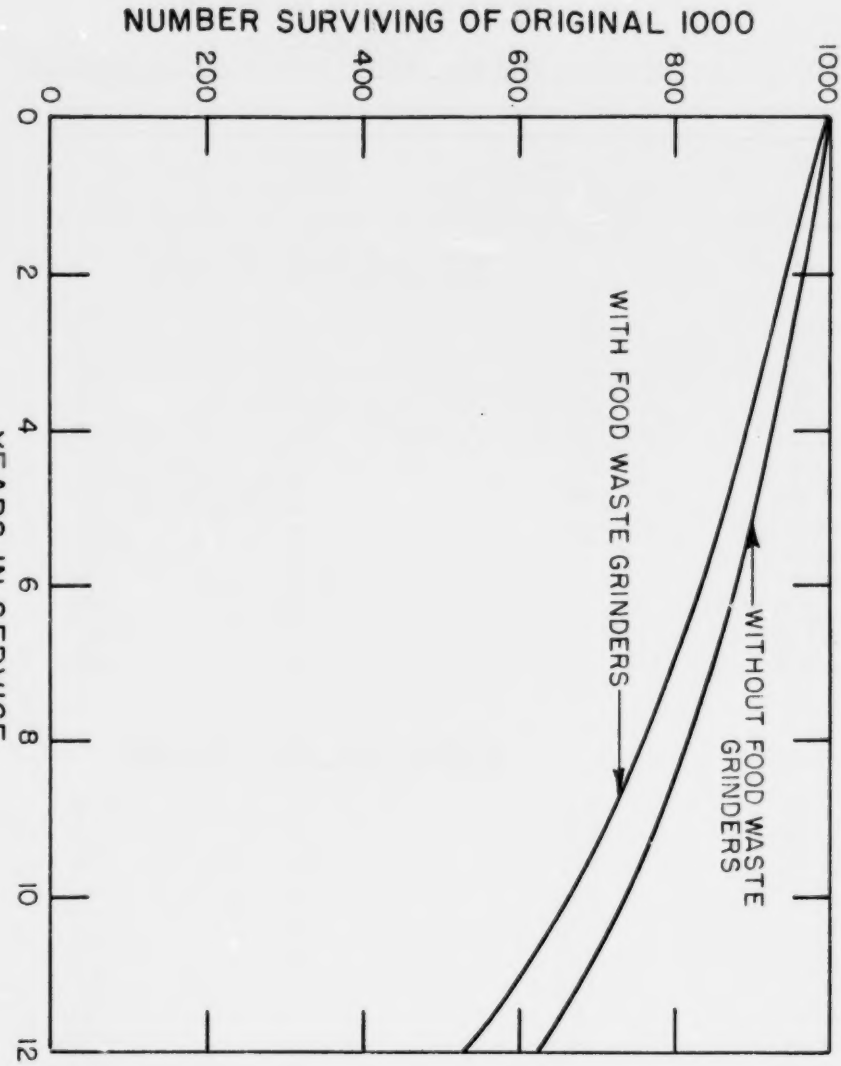
Basic data, calculations, and curves for each of the areas studied are presented in the Appendix (pages 4, 5, 27, 44, 61, and 74). In these data it will be noted that in each of the areas, except Dallas County, the food waste grinder systems show a consistently lower survival. In Dallas County survival was high for both groups of systems.

A composite survival curve for Dallas, Tarrant, Wyandotte, and Polk Counties combined (all trench-type systems) is shown in Figure 2. The calculations are shown in Table 5. It is apparent from these data that performance of the systems with food waste grinders is generally poorer than the systems without food waste grinders. This is true even though some greater capacity has been provided for the food waste grinder systems.

Table 5

Survival Curve Calculations
Combined Data
Dallas, Tarrant, Wyandotte, and Polk Counties

Age of System	Number Reaching Age	Number Failed	q_x	l_x	d_x
		With Food Waste Grinders			
0-0.9	623	16	.026	1000	26
1.0-1.9	574	15	.026	974	25
2.0-2.9	500	24	.048	949	46
3.0-3.9	389	14	.036	903	33
4.0-4.9	255	6	.024	870	21
5.0-5.9	124	3	.024	849	20
6.0-6.9	41	0	.000	829	0
7.0-7.9	14	1	.071	829	59
8.0-8.9	6	0	.000	770	0
9.0-9.9	5	1	.200	770	154
10.0-10.9	1	0	.000	616	0
11.0-11.9	1	0	.000	616	0
12.0-12.9	1	0	.000	616	0
		Without Food Waste Grinders			
0-0.9	498	11	.022	1000	22
1.0-1.9	470	6	.013	978	13
2.0-2.9	431	12	.028	965	27
3.0-3.9	371	6	.016	938	15
4.0-4.9	293	10	.034	923	31
5.0-5.9	228	5	.022	892	20
6.0-6.9	162	4	.025	872	22
7.0-7.9	81	3	.037	850	31
8.0-8.9	45	3	.067	819	55
9.0-9.9	22	1	.045	764	34
10.0-10.9	13	2	.154	730	112
11.0-11.9	7	0	.000	618	0
12.0-12.9	4	1	.250	618	154
13.0-13.9	1	0	.000	464	0



SURVIVAL CURVES - COMBINED DATA
POLK, WYANDOTTE, DALLAS, AND TARRANT COUNTIES

FIGURE 2

Soil Area Used. In analyses developed in the Seepage Bed Report,(6) the relationship between the amount of soil absorption area used (wetted) at any time under a given sewage loading may be expressed by the equation:

(1)
$$A = \frac{Q}{kL} + \frac{Q}{L} t$$

where:

A is the amount of soil area wetted in square feet,

t is the age of the system in years,

k is the rate reaction constant of soil clogging per year,

L is the cubic feet of effluent that one square foot of soil will ultimately absorb,

Q is the loading factor reflecting the characteristics of sewage generated in the home (including the effect of food waste grinders), amount of treatment given to the sewage, the number of persons using the system, and the volume of liquid discharged to the system.

An areal load capacity concept has also been described(8) where the relationship between soil, load, area, and time may be expressed as:

(2)
$$L = \frac{fPt}{A}$$

where:

fP is the "equivalent" population load. P is the number of persons in the household, and f is a factor representing the type of treatment and the presence or absence of food

waste grinders. Since the bulk of available information pertains to septic tank effluent from homes without food waste grinders, it is convenient to set f=1 for households with septic tanks but not using food waste grinders. If food waste grinders are used f may be different from unity, larger if food waste grinders result in a greater amount of soil area used,

L, t, and A are as defined previously.

In this form P is an expression of loading. If it is replaced by annual water use in cubic feet, Q, as an expression of loading, the following equation would result:

(3)

$$L = \frac{fQt}{A} \quad \text{or} \quad A = \frac{fQt}{L}$$

Referring to equation (1), the areal load capacity concept would have merit where k is very large and the first term approaches zero. The second term, $\frac{Qt}{L}$, would be significant and would be equivalent to the areal load capacity.

Utilizing the average transmission rate approach developed in the Seepage Bed Report and the areal load capacity concept, L's for systems with and without food waste grinders may be calculated. Using these values and a water use of 50 gallons per capita per day for a home occupancy of 4 persons, general design equations for each class of system in each area were developed. In the analyses of data it is convenient to use the reciprocal form, since, as may be shown, the reciprocal of the average transmission rate, $\frac{A}{Q}$, should give a straight line when plotted against time, t. The slope of the line is $\frac{1}{L}$.

The general design equations along with the reciprocal L values for soils in four counties are shown in Table 6. Also shown in this table are the ratios of L for systems with food waste grinders to L for systems without food waste grinders. This ratio is equivalent to the ratio of the f for systems with food waste grinders to f for systems without food waste grinders. Since it is convenient to set f=1 for systems without food waste grinders, the ratio is equivalent to the f for systems with food waste grinders.

In Maricopa County seepage pits there is no significant difference between the L's; in other words, there is no significant difference in the rate of use of soil area between systems with and without food waste grinders.

In the trench-type systems in Wyandotte, Polk, and Dallas Counties, the food waste grinder systems have a higher rate of use of soil area. The probability of significance of the differences ranges from .66 to .94.

The values of f for the trench systems with food waste grinders range from 1.09 to 1.43. Considering the trench systems as a combined group, the mean f for food waste grinders is 1.25 with a standard deviation of .16. This value is significantly different from f=1 at about the 95 percent level. In other words, the food waste grinders significantly affect the rate of use of soil area. Systems with food waste grinders required about 25 percent additional absorption area to obtain a comparable period of service.

Most Economical Design. The effect of food waste grinders on the cost of soil absorption systems may be appraised by a method of economic analysis developed by Thomas[8] and applied in a previous report.[6] The applicability of present soil absorption system design standards may also be judged with the aid of this tool.

Table 6

Summary of Soil Absorption Area Used
Systems With and Without Food Waste Grinders

County and State	General Design Equation*	No. of Obs.	Reciprocal of L, Ft^2/Ft^3			Ratio $\frac{L_{with}}{L_{without}}$		Prob. of Diff.
			Mean	Std. Dev.	Prob. of Diff.	Mean	Std. Dev.	
Maricopa, Ariz.								
With FWG	A = 27.3t	12	.0028	.0051	.50	0.96	0.51	.50
Without FWG	A = 28.3t	30	.0029	.0009				
Wyandotte, Kan.								
With FWG	A = 231.3t	8	.0237	.0160	.91	1.43	0.42	.85
Without FWG	A = 162.0t	11	.0166	.0089				
Polk, Iowa								
With FWG	A = 64.4t	19	.0066	.0038	.94	1.35	0.26	.91
Without FWG	A = 47.8t	15	.0049	.0026				
Dallas, Texas								
With FWG	A = 58.6t	22	.0060	.0043	.66	1.09	0.23	.60
Without FWG	A = 53.7t	21	.0055	.0036				

*Where A is total wetted area (bottom and sidewall) in square feet, and t is the time in service in years.

The total cost of the soil absorption system may be divided into: (1) the initial cost, and (2) the future costs of renewals of the system at regular intervals. Renewal periods can be related to the amount of absorption area provided through the areal load capacity concept discussed previously. Using these factors and the economic analysis cited, it is possible to arrive at optimum designs based on present value of total costs.

From discussions with builders and contractors in the field study areas, it was determined that the cost of narrow trench-type systems could be estimated from a flat charge of $64.00 plus $1.00 per square foot of bottom absorption area installed. The first charge includes an estimate for costs of administration and enforcement of a septic tank program. It was also determined that the cost of renewals or replacements is generally about 20 percent greater than the original cost. Employing an economic time horizon of 30 years and an interest rate of 5 percent, the present value of total costs has been determined for various designs.

The minimum costs for systems with and without food waste grinders in "good," "fair," and "poor" soils are given in Table 7. It will be noted that the minimum costs for systems designed with grinders are about 20 percent greater than for systems designed without grinders.

It is also possible to calculate costs of systems based on the Manual of Septic Tank Practice design areas but with the soils performing according to the mathematical model equations as expressed by the areal load capacity concept. Relative costs of trench-type systems designed according the Manual of Septic Tank Practice vs. the mathematical model equations are shown in Table 8.

Table 7

Relative Costs of Systems Designed With and Without Food Waste Grinders in Three "Soils"

Soil	Model Equation*		Present Value of Total Costs for Optimum Design	
	With	Without	With (Dollars)	Without (Dollars)
"Good"	A = 20.3t	A = 16.3t	658.60	559.22
"Fair"	A = 27.1t	A = 21.7t	823.00	693.09
"Poor"	A = 58.1t	A = 46.5t	1531.57	1271.97

*The model equations are based on estimates of L from all available data and using f=1.25 for systems with food waste grinders; A is the square feet of bottom area required for t years of service.

Table 8

Relative Cost of Systems Manual of Septic Tank Practice Design vs. Optimum Design

Soil	Present Value of Total Costs (Dollars)	
	Optimum Design for With Systems	MSTP Design but Performance as With Model
"Good"	658.60	682.78
"Fair"	823.00	890.41
"Poor"	1531.57	1802.49

It is apparent that the Manual of Septic Tank Practice design areas (bottom area) may be used for systems that will receive ground food wastes without incurring a serious economic penalty.

"Starting" of Digestion.

Interference of ground food wastes with the "starting" of a septic tank would be reflected in noticeable odors during the early life of the system. Careful questioning of homeowners during the general surveys as to the existence of odors or other nuisances during the early period of use of the system revealed no complaints peculiar to systems with food waste grinders.

Serious lag in "starting" of the septic tank would also result in untreated or poorly treated sewage being discharged to the soil absorption system. This should be reflected in high early failure rates. The survival curves following pages 5, 27, 44, 61, and 74 in the Appendix show no trend toward high early failures in either the with or without food waste grinder systems in any of the areas studied. Likewise, the combined curve of Figure 2 shows no trend toward high early failures.

In the table below the number of failures of systems at ages of less than one year are tabulated. It will be noted that among some 1800 systems observed only about 2 percent failed during the first year of life. There is no significant difference between the failure rates of the two categories of systems.

	Satisfactory	Failed	Total	Percent Failed
With FWG	716	17	733	2.3
Without FWG	1014	22	1036	2.1
Total	1730	39	1769	2.2

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The effect of food waste grinders on septic tank-soil absorption systems was investigated in four localities in three different states. Data were also abstracted from other septic tank system studies conducted in several other localities and states. The cooperation and assistance of the state and local health departments contributed greatly to the success of the endeavor. Food waste grinder manufacturers and distributors co-operated in locating potential study areas.

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APPENDIX

Section		Page No.
I	Data from Other FHA Studies	1
II	Wyandotte County, Kansas	16
III	Polk County, Iowa	33
IV	Tarrant County, Texas	50
V	Dallas County, Texas	63
VI	Data Forms	83

Data from Other FHA Studies

GENERAL INFORMATION

A review of data available from other FHA studies was the first approach to the investigation of the effect of food waste grinders on the performance of septic tank systems. Details of the other studies are presented in separate reports.*

A summary of the data showing the distribution of homes with and without food waste grinders in the other study areas is shown in Table 1. Only 354, about 13 percent, out of 2723 homes on which complete case histories were available were equipped with food waste grinders.

Gross Performance.

The influence of food waste grinders on the rate of failure of soil absorption systems examined in the distribution box study has been discussed in a previous report. In that study a significantly greater failure rate was observed in systems having food waste grinders.

A summary of the gross performance of the systems in other study areas where sufficient data were available is shown in Table 2. Data were either insufficient in some of the areas shown in Table 1, or confounding factors made it impractical to compare classes of systems. Of the four areas where data were available, only in San Diego County was there a significant difference in performance between systems with and without food waste grinders; however, in that

*Reports to the FHA: Effectiveness of the Distribution Box, February 1958; Study of Seepage Beds, December 1960; Study of Seepage Pits (in preparation).

area the systems without food waste grinders which had the higher failure rates had about twice the average age of the systems with food waste grinders and were installed in "poorer" soils.

Table 1

Summary of Distribution of Food Waste Grinders in Previous Study Areas

Study	Area	Number of Homes			Percent
		With	Without	Total	With
Distribution Box	St. Louis Co., Missouri	64	351	415	15
	Rapides Parish, Louisiana	6	316	322	2
	Caddo Parish, Louisiana	34	575	609	6
Seepage Bed	Knox Co., Tennessee	0	75	75	0
	Mecklenburg Co., North Carolina*	51	291	342	15
	Bergen Co., New Jersey	0	97	97	0
	Kent Co., Michigan	26	30	56	46
	Muskegon Co., Michigan	5	71	76	7
	Ingham Co., Michigan	44	84	128	34
Seepage Pit	Maricopa Co., Arizona	25	231	256	10
	San Diego Co., California	65	97	162	40
	Fresno Co., California	4	32	36	11
	Los Angeles Co., California	19	10	29	66
	Santa Clara Co., California	5	16	21	24
	Sacramento Co., California	6	20	26	23
	Jefferson Co., Kentucky	0	14	14	0
	Nueces Co., Texas	0	59	59	0
Total		354	2369	2723	13

*Includes Seepage Beds and Narrow Trenches.

Table 2

Summary of Performance of
Systems With and Without Food Waste Grinders
from Other FHA Studies

Location	Years of Service		Mean Persons (No.)	Mean Area Provided* (Ft^2)	Performance				Difference
	Mean	Range			No. of Obs.	No. Satis-factory	No. Failed	Percent Failed	
Maricopa Co., Ariz.									
With FWG	5.0	1.8-9.8	3.9	122	25	19	6	24	Not Significant
Without FWG	4.8	0.2-11.4	3.5	129	231	167	64	28	
San Diego Co., Calif.									
With FWG	3.7	0.8-9.5	4.2	160	65	65	0	0	Significant
Without FWG	6.6	1.0-17.2	3.9	198	97	89	8	8	
Mecklenburg Co., N.C.									
With FWG	4.8	1.9-7.1	3.2	576	19	13	6	32	Not Significant
Without FWG	5.5	0.6-10.5	3.2	555	231	175	56	24	
Kent Co., Mich.									
With FWG	2.3	1.8-2.8	4.4	595	25	25	0	0	Not Significant
Without FWG	4.6	2.1-8.9	4.0	378	17	16	1	6	

*Sidewall Area in the case of Seepage Pits; Bottom Area in the case of Seepage Beds or Trenches.

Survival Curves.

Data were available in three areas for calculations of survival curves: Mecklenburg County, North Carolina; San Diego County, California; and Maricopa County, Arizona. The calculations and survival curves are shown in Table 3 and Figure 1, respectively. The seepage pits in Maricopa and San Diego Counties show little difference in survival between the systems with and without food waste grinders. In the seepage bed systems in Mecklenburg County after about four years the food waste grinder systems show a lower survival.

Table 3

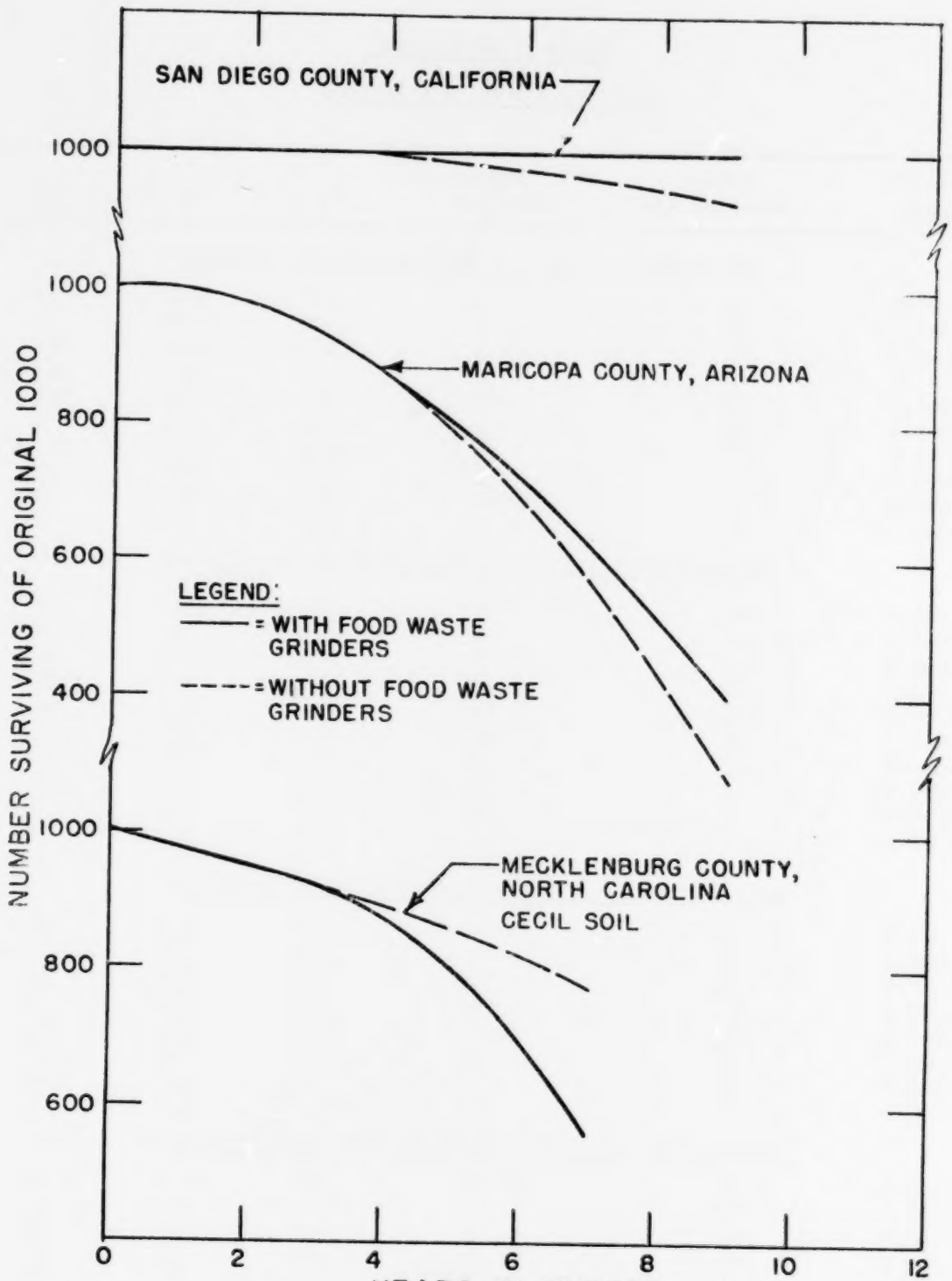
Survival Curve Calculations

Age of System	Number Reaching Age	Number Failed	q_x	l_x	d_x
	San Diego Co., Calif. - With Food Waste Grinders				
0-0.9	66	0	.000	1000	0
1.0-1.9	65	0	.000	1000	0
2.0-2.9	58	0	.000	1000	0
3.0-3.9	50	0	.000	1000	0
4.0-4.9	15	0	.000	1000	0
5.0-5.9	7	0	.000	1000	0
6.0-6.9	7	0	.000	1000	0
7.0-7.9	3	0	.000	1000	0
8.0-8.9	1	0	.000	1000	0
9.0-9.9	1	0	.000	1000	0
	San Diego Co., Calif. - Without Food Waste Grinders				
0-0.9	90	0	.000	1000	0
1.0-1.9	90	0	.000	1000	0
2.0-2.9	87	0	.000	1000	0
3.0-3.9	81	1	.012	1000	12
4.0-4.9	68	0	.000	988	0
5.0-5.9	61	1	.016	988	16
6.0-6.9	53	0	.000	972	0
7.0-7.9	43	2	.046	972	45
8.0-8.9	19	0	.000	927	0
9.0-9.9	8	1	.125	927	116

Table 3 (Continued)

Survival Curve Calculations

Age of System	Number Reaching Age	Number Failed	q_x	l_x	d_x
	Maricopa Co., Ariz. - With Food Waste Grinders				
0-0.9	25	0	.000	1000	0
1.0-1.9	25	0	.000	1000	0
2.0-2.9	24	2	.083	1000	83
3.0-3.9	19	1	.053	917	49
4.0-4.9	13	1	.077	868	67
5.0-5.9	10	0	.000	801	0
6.0-6.9	7	1	.943	801	115
7.0-7.9	4	1	.250	686	172
8.0-8.9	1	0	.000	514	0
9.0-9.9	0	0	.000	514	0
	Maricopa Co., Ariz. - Without Food Waste Grinders				
0-0.9	226	2	.009	1000	9
1.0-1.9	221	4	.018	991	18
2.0-2.9	210	7	.033	973	32
3.0-3.9	168	12	.071	941	67
4.0-4.9	135	14	.104	874	90
5.0-5.9	89	15	.169	784	132
6.0-6.9	42	7	.167	652	109
7.0-7.9	3	1	.333	543	181
8.0-8.9	0	0	.000	362	0
9.0-9.9	0	0	.000	362	0
	Mecklenburg Co., N.C. - With Food Waste Grinders				
0-0.9	19	1	.053	1000	53
1.0-1.9	18	0	.000	947	0
2.0-2.9	18	1	.056	947	53
3.0-3.9	14	0	.000	894	0
4.0-4.9	14	1	.071	894	63
5.0-5.9	8	2	.250	831	208
6.0-6.9	4	1	.250	623	156
7.0-7.9	1	0	.000	467	0
	Mecklenburg Co., N.C. - Without Food Waste Grinders				
0-0.9	222	9	.040	1000	40
1.0-1.9	211	4	.019	960	18
2.0-2.9	200	5	.025	942	24
3.0-3.9	184	9	.049	918	45
4.0-4.9	161	7	.043	873	38
5.0-5.9	119	5	.042	835	35
6.0-6.9	81	12	.147	800	118
7.0-7.9	36	3	.083	782	65



SURVIVAL CURVES
DATA FROM OTHER FHA STUDIES

FIGURE 1

Soil Area Used.

Maricopa County, Arizona. In the seepage pit study conducted in Maricopa County, Arizona, the majority of the food waste grinder cases encountered were in two adjacent subdivisions. The soils in these subdivisions were very similar, consisting of interbedded strata of gravelly loam and silty clay loam to beyond the depth of the seepage pit installations. These locations afforded the only direct comparison between the with and without food waste grinder systems on the basis of soil area used. Basic data on system loadings and soil areas used are shown in Table 4.

Based on an analysis developed in the Seepage Bed Report,* the relationship between the amount of soil area used for a given liquid loading in a given time may be expressed by the equation:

$$A = \frac{Q}{kL} + \frac{Q}{L} t$$

where:

k and L are soil parameters,

A is soil area wetted in square feet,

Q is annual water use in cubic feet,

t is time of service in years.

Employing the average transmission rate concept described in the Seepage Bed Report, the average area wetted relationships for the two classes of systems may be expressed as follows:

With FWG $A = .0028\ Qt$

Without FWG $A = .0029\ Qt$

As in the gross performance and survival curve comparisons there is no significant difference between the systems with and without food waste grinders in the rate of use of soil area.

*Study of Seepage Beds. Report to the Federal Housing Administration, Robert A. Taft Sanitary Engineering Center, December 15, 1960.

Table 4

Soil Absorption System Data
Detailed Studies
Squaw Peak Heights and McLellan Manor
Maricopa County, Arizona

System Number	Time in Service (Yrs.)	Persons (No.)	Total Area Used (Ft^2)	Water Use* $Ft^3/Yr.$	Apparent Application Rate $Ft^3/Ft^2/Yr.$	Reciprocal of Application Rate Ft^2/Ft^3 x Yrs.
			With Food Waste Grinders			
20	3.0	5.0	162	17,700	109	.009
36	3.5	5.0	144	11,300	79	.013
38	3.8	3.0	52	6,900	133	.008
30	3.9	3.5	117	9,200	78	.013
32	3.9	4.0	0	13,700	-	.000
35	4.1	6.0	152	8,800	58	.017
19	4.7	4.0	151	7,600	50	.020
5	5.2	1.6	66	7,700	117	.009
28	5.6	2.0	114	13,200	116	.009
1	5.7	5.0	356	10,300	29	.035
6	6.0	3.0	247	6,700	27	.037
15	6.1	3.9	112	7,000	63	.016
Mean	4.8	3.1	137	9,900	88	.015
Std. Dev.	1.1	1.0	64	4,000	69	.006
			Without Food Waste Grinders			
26	3.0	5.0	132	26,200	198	.005
40	3.0	3.2	0	6,300	-	.000
29	3.2	2.0	108	13,100	121	.008
31	3.3	3.4	55	5,200	95	.011
17	3.3	4.0	35	11,800	338	.003
37	3.8	4.0	142	11,000	78	.013
10	3.9	3.0	223	9,800	44	.023
41	4.0	2.0	101	9,100	90	.011
33	4.0	2.2	43	11,900	276	.004
39	4.0	4.0	60	5,700	95	.011

Table 4 (Continued)

Soil Absorption System Data
Detailed Studies
Squaw Peak Heights and McLellan Manor
Maricopa County, Arizona

System Number	Time in Service (Yrs.)	Persons (No.)	Total Area Used (Ft^2)	Water Use* $Ft^3/Yr.$	Apparent Application Rate $Ft^3/Ft^2/Yr.$	Reciprocal of Application Rate $Ft^2/Ft^3 \times Yrs.$
			Without Food Waste Grinders (Continued)			
2	4.1	3.0	132	12,800	97	.010
21	4.4	5.0	211	10,700	51	.020
4	4.6	3.5	223	11,200	50	.020
18	4.8	3.7	142	13,000	92	.011
24	4.9	2.8	96	7,800	82	.012
11	4.9	4.0	128	10,100	79	.013
3	5.0	2.0	90	8,000	89	.011
8	5.2	4.0	218	9,100	42	.024
9	5.2	1.9	143	8,800	61	.016
23	5.4	3.3	205	10,200	50	.020
14	5.5	2.8	158	7,700	49	.020
25	5.7	4.3	145	7,900	54	.018
22	5.8	3.8	172	9,900	57	.017
7	5.8	2.0	245	12,200	50	.020
27	6.0	2.0	75	4,700	63	.016
12	6.1	3.3	208	8,800	42	.024
13	6.1	3.5	177	10,300	58	.017
458	6.1	2.0	126	6,200	49	.020
16	6.2	1.5	111	4,600	41	.024
457	6.3	4.0	210	12,700	60	.016
Mean	4.6	3.8	134	10,000	78	.016
Std. Dev.	1.0	1.3	92	3,400	37	.011

*Based on water use during December, January, and February.

Scum and Sludge Accumulations.

Detailed information on accumulation of scum and sludge where systems with food waste grinders may be compared to systems without food waste grinders was available from two previous study areas, Maricopa County, Arizona and Duval County, Florida. The data from Maricopa County were obtained during the seepage pit study. The data from Duval County were obtained in 1951.

Maricopa County, Arizona. Solids accumulations data were available from 42 detailed study cases, 12 with and 30 without food waste grinders. The basic data are shown in Table 6. A summary of the data is given in Table 5. It will be noticed that very little difference was observed in the accumulation of scum and sludge.

Table 5

Solids Accumulations
Maricopa County, Arizona

Item	With Food Waste Grinder (12 Systems)		Without Food Waste Grinder (30 Systems)	
	Mean	Standard Deviation	Mean	Standard Deviation
Age, Yrs.	4.9	1.0	5.0	1.0
Persons, No.	3.8	1.3	3.1	1.0
Septic Tank Capacity, Gals./Person	191	72	206	84
Solids Accumulations Ft^3/Person/Yr.				
Scum	0.86	0.34	0.97	0.38
Sludge	0.88	0.38	0.85	0.42
Scum and Sludge	1.74	0.63	1.82	0.65

Table 6

Septic Tank Data
Scum and Sludge Accumulations
Detailed Studies
Squaw Peak Heights and McLellan Manor
Maricopa County, Arizona

System Number	Time in Service (Yrs.)	Persons (No.)	Tank Capacity (Gals.)	Solids Accumulations (Ft^3)		
				Floating Scum	Submerged Scum	Sludge
			With Food Waste Grinders			
5	5.2	1.6	500	1.6	8.0	4.8
19	5.4	4.0	500	0.8	12.8	20.8
28	5.6	2.0	500	6.4	5.6	5.6
20	5.7	5.0	500	*	13.0	13.0
1	5.7	5.0	500	0.8	5.6	9.6
6	6.0	3.0	500	1.6	13.6	16.8
15	6.1	3.9	1000	3.8	15.8	28.1
36	3.5	5.0	810	16.8	7.2	31.2
38	3.8	3.0	750	2.4	13.2	8.4
30	3.9	3.5	810	4.1	8.1	13.5
32	3.9	4.0	810	1.2	13.2	18.0
35	4.1	6.0	750	19.2	0.0	25.2
			Without Food Waste Grinders			
17	3.3	4.0	500	0.8	6.4	0.4
26	4.2	5.0	750	14.3	4.4	8.8
2	4.6	3.0	500	1.9	3.8	12.0
18	4.8	3.7	500	1.6	13.6	4.0
24	4.9	2.8	500	10.9	6.7	12.0
11	4.9	4.0	500	*	16.0	17.6
3	5.0	2.0	500	4.0	8.0	15.2
10	5.0	3.0	500	*	14.4	9.6
8	5.0	4.0	500	0.8	14.4	11.2
9	5.2	1.9	500	3.2	9.6	11.2
23	5.4	3.3	500	4.0	10.4	16.0
25	5.7	1.3	500	1.6	5.4	8.0
22	5.8	3.8	500	3.2	14.4	11.8
7	5.8	2.0	500	4.8	9.6	14.4
21	5.8	5.0	500	*	14.5	17.5
4	5.9	3.5	500	2.4	3.2	5.6
27	6.0	2.0	500	5.6	11.2	3.2
14	6.0	2.8	500	*	17.4	20.7
12	6.1	3.3	500	8.0	10.4	12.0
13	6.1	3.5	500	3.2	12.8	15.2
16	6.2	1.5	500	2.4	11.2	9.6

Table 6 (Continued)

Septic Tank Data
Scum and Sludge Accumulations
Detailed Studies
Squaw Peak Heights and McLellan Manor
Maricopa County, Arizona

System Number	Time in Service (Yrs.)	Persons (No.)	Tank Capacity (Gals.)	Solids Accumulations (Ft^3)		
				Floating Scum	Submerged Scum	Sludge
			Without Food Waste Grinders (Continued)			
457	6.3	4.0	500	0.8	18.4	20.8
458	6.5	2.0	500	2.4	10.4	10.4
40	3.0	3.2	750	1.2	15.6	9.6
29	3.2	2.0	750	1.2	8.1	11.5
31	3.3	3.4	750	3.6	16.8	30.0
41	4.0	2.0	750	1.2	8.4	12.0
33	4.0	2.2	750	1.2	13.2	3.6
37	4.0	4.0	750	3.6	18.0	7.2
39	4.0	4.0	750	1.2	10.8	16.8

*Tank surcharged, floating and submerged scum not differentiated.

Duval County, Florida. During a previous series of studies, septic tanks at 35 homes in Duval County were examined in detail for solids accumulation information, 16 with and 19 without food waste grinders. Data for these systems have been reported previously.* A summary of the information and the basic data on individual cases are shown in Tables 7 and 8, respectively. The average sludge plus scum accumulation in the food waste grinder tanks was about 77 percent greater than in the non-food waste grinder tanks. The larger part of the increase was in the scum, averaging 210 percent; while the sludge increase averaged 31 percent.

*Studies on Household Sewage Disposal Systems, Part III. Public Health Service Publication No. 397, 1955.

Table 7

Solids Accumulations
Duval County, Florida

Item	With Food Waste Grinder (16 Systems)		Without Food Waste Grinder (19 Systems)	
	Mean	Standard Deviation	Mean	Standard Deviation
Age, Yrs.	3.22	0.46	3.67	0.22
Persons, No.	3.81	2.04	3.95	0.97
Septic Tank Capacity, Gals./Person	256	152	165	42
Solids Accumulations, Ft^3/Person/Yr.				
Scum	1.51	1.26	0.49	0.45
Sludge	1.82	1.40	1.39	0.79
Scum and Sludge	3.33	2.16	1.88	1.60

Table 8

Septic Tank Data
Scum and Sludge Accumulations
Detailed Studies
Duval County, Florida

System Number	Time in Service (Yrs.)	Persons (No.)	Tank Capacity (Gals.)	Solids Accumulations (Ft^3)		
				Floating Scum	Submerged Scum	Sludge
With Food Waste Grinders						
11-15	1.6	2	720	3.9	3.9	13.9
11-9	3.1	5	817	3.3	8.1	16.5
11-10	3.1	5	647	12.4	20.3	13.4
11-13	3.2	4	790	3.3	5.0	18.9
11-22	3.2	3	718	1.0	2.0	14.7
11-4	3.2	5	671	5.4	19.3	13.7
11-24	3.2	1	707	2.8	6.2	19.4
11-40	3.3	2	837	9.0	23.0	12.0
11-1	3.4	4	791	4.2	5.3	21.6
11-3	3.4	4	781	9.0	7.4	8.2
11-5	3.4	4	672	9.8	14.7	14.1
11-8	3.4	10	781	4.8	0.4	19.1
11-11	3.4	4	750	2.7	2.7	26.1
11-14	3.5	5	785	NS	NS	30.0
11-16	3.5	3	801	7.5	5.9	12.5
11-12	3.5	2	750	8.4	10.7	10.0
Without Food Waste Grinders						
11-2	3.2	5	616	NS	NS	20.2
11-7	3.4	4	663	0.9	6.0	9.1
11-34	3.5	4	512	4.3	7.7	13.2
11-33	3.5	5	583	NS	NS	35.0
11-30	3.5	5	618	4.9	10.3	11.4
11-19	3.6	3	615	1.5	1.0	18.9
11-20	3.6	4	589	0.8	1.7	17.8
11-38	3.6	5	603	4.6	6.9	17.1
11-36	3.6	3	585	TS	TS	11.8

Table 8 (Continued)

Septic Tank Data
Scum and Sludge Accumulations
Detailed Studies
Duval County, Florida

System Number	Time in Service (Yrs.)	Persons (No.)	Tank Capacity (Gals.)	Solids Accumulations (Ft^3)		
				Floating Scum	Submerged Scum	Sludge
			Without Food Waste Grinders (Continued)			
11-6	3.7	6	606	4.0	5.1	20.0
11-23	3.7	3	608	3.0	2.6	13.6
11-29	3.7	3	670	7.4	10.7	30.1
11-37	3.7	3	534	TS	TS	41.1
11-18	3.8	3	631	4.0	3.7	20.7
11-27	3.8	3	695	0.4	1.2	11.1
11-25	4.0	4	643	5.0	14.3	30.0
11-26	4.0	5	654	6.3	2.3	17.2
11-31	4.0	3	614	3.8	6.2	8.6
11-32	4.0	4	615	3.2	0.8	15.7

NS indicates no scum.

TS indicates trace of scum.

Wyandotte County, Kansas

GENERAL INFORMATION

Climate.

Wyandotte County, having an area of about 151 square miles, is located in the extreme northeast corner of the State of Kansas. Population of the county in 1960 was estimated at about 185,000, with about 122,000 of the total being in Kansas City.

The area comes just within the eastern edge of the humid-climate belt and borders on the subhumid-climate belt. A summary of climatic factors that may influence septic tank system performance is shown in Table 9. The frost-free season ranges from about 164 days to 216 days. Winters may be rather severe and on the average about 68 freeze and thaw alternations can be expected. Annual potential evapotranspiration is about 31 inches.

Soils and Topography.

The county is bounded on the north and east by the Missouri River and on the south by the Kansas River. Topography is gently rolling. The ground surface is deeply dissected, with elevations ranging from less than 740 feet along the rivers to about 1060 feet on the uplands in the western part of the county. Surface drainage is good.

Soils have developed primarily from deep loessial parent material with only small areas of glacial till, residual, and alluvial soils. Soils of the

Table 9

Summary of Climatological Data
Wyandotte County, Kansas*

Temperature, Precipitation, and Sunshine
for Years of Record from 1905 to 1960

Season	Temperature, °F			Precipitation, Inches			Percent of Possible Sunshine
	Mean	Mean Maximum	Mean Minimum	Mean Total	Driest Year	Wettest Year	
Annual	56	65	46	36	22	50	64
Winter (Dec.Jan.Feb.)	32	41	24	4.3	1.1	10	52
Summer (Jun.Jul.Aug.)	77	87	68	12.4	1.1	23	73

Temperature and Precipitation for
Years Preceding and During Survey

Dates	Mean Temperature, °F			Mean Precipitation, Inches		
	Annual	Winter	Summer	Annual	Winter	Summer
1950-59	56	34	79	33	3.7	13
1955-59	56	33	79	34	4.4	12
Aug.'58-Jul.'59	57	57	78	34	3.2	7.9

*Weather Bureau Station located in Kansas City, Missouri.

county have not been completely mapped; however, the deep loessial soils are very similar throughout the county. They occur in about 90 percent of the unsewered residential building areas. Texture of the soils ranges from silt to silty clay. Internal drainage ranges from moderate to moderately slow.

Health Department Organization and Septic Tank Practice.

The health department is a combined city-county unit. At the time of these studies the sanitation staff included one sanitary engineer and seven sanitarians. Of this complement, two sanitarians spent about 50 percent of their time on septic tank control activities. During the peak of the building season practically all of the sanitarians spend some time in this activity. The sanitary engineer and one clerk devote about 10 percent of their time to septic tank control.

Organized control of septic tank systems in the county has been in effect since about 1940. The first control authority was contained in county zoning and planning regulations, and essentially conformed to the Kansas State Board of Health regulations. Minimum septic tank capacity requirements have been gradually raised from 500 gallons to 800 gallons under present regulations. Where food waste grinders are used a 1000-gallon tank is required. Minimum soil absorption area requirements have remained constant at 500 square feet of bottom area. In split systems, which are permitted, the total trench area must be increased to 550 square feet.

RESULTS OF FIELD STUDIES

Field work was conducted in Wyandotte County from May 1, 1959 to August 26, 1959. The lack of detailed records required preliminary screening of almost 100 subdivisions by telephone and personal interviews with homeowners in order to select six subdivisions that were considered satisfactory for study. These six subdivisions are in the central upland part of the county. They are all within a one-mile radius and are in the loessial soil area. A total of 167 general survey cases and 24 detailed studies were completed.

Subdivision Descriptions.

Country Club Estates contains 50 lots and 27 homes of which 24 were surveyed. The ages of the homes range from 0.6 to 5.7 years. Estimated prices of the homes range from $15,000 to $25,000. The subdivision lies on the crest of a small knoll with ground slopes generally over five percent.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	9	8	1
Without FWG	15	14	1

Victory Hills Manor is immediately adjacent on the east to Country Club Estates. It contains 35 lots and 25 homes of which 20 were surveyed. Ages of the homes range from 0.7 to 5.2 years. This subdivision is very similar to Country Club Estates in type of home and topography.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	4	3	1
Without FWG	16	16	0

White Church Gardens contains 33 homes of which 32 were surveyed. The estimated price range of the homes is from $12,000 to $17,000. The subdivision is located on the highest ground in the vicinity. There has been some cut and fill, and a few yards have steep terraces.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	8	7	1
Without FWG	24	19	5

Lakeview Gardens consists of 49 homes of which 33 were surveyed. The price range of the homes and the topography is very similar to White Church Gardens. The ages of the homes range from 0.4 to 4.6 years.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	8	8	0
Without FWG	25	25	0

Westdale subdivision consists of 23 homes of which 21 were surveyed. All of the homes and septic tank systems were constructed by one contractor. Most of the homes are in the three to four year age range. Prices were estimated to range from $15,000 to $22,000.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	14	5	9
Without FWG	7	6	1

Glenwood Park subdivision consists of 35 homes and all were surveyed. Ages range from 0.2 to 4.6 years. Slopes in the subdivision range up to 25 percent with considerable cut and fill. Price range of the homes was estimated from $12,000 to $20,000.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	13	9	4
Without FWG	22	19	3

Soils Descriptions.

While no published soil survey map is available, the Soil Conservation Service office in the area indicated that the soils would be classed in the Sharpsburg-Brundy-Summit soils group. The soil mantle is exceedingly deep, being greater than 10 feet. Drainage may be classed as moderate to well drained. A representative profile is as follows:

0"-10" Dark olive gray to black silty clay of fine crumb structure.

10"-16" Dark grayish brown to dark brown granular silty clay.

16"-40"+ Dark grayish brown to olive gray massive or blocky structure, ranging in texture from silty clay to clay.

Percolation tests conducted in accordance with the Manual of Septic Tank Practice were made at five different sites. Results of these tests are given in Table 10.

Table 10

Percolation Test Results
Wyandotte County, Kansas

Number of Test Sites	Number of Test Holes	Percolation Rate (Min./In.)		
		Average	Standard Deviation	Range
5	28	21	18	6-66

Construction and Loading.

Construction and loading characteristics of the soil absorption systems surveyed in Wyandotte County classified by food waste grinder usage are shown in Table 11.

Table 11

Construction and Loading
Wyandotte County, Kansas

Factor	With Food Waste Grinder (53 Systems)		Without Food Waste Grinder (114 Systems)	
	Median	Range	Median	Range
Age of System, Yrs.	2.8	0.3-5.7	3.0	0.2-5.8
Persons/Home, No.	3.0	2.0-5.8	3.4	2.0-7.0
Septic Tank Capacity, Gals.	810	250-1800	810	500-1650
Width of Trench, In.	24	24-42	24	23-84
Length of Trench, Ft.	250	115-354	250	25-400
Bottom Area of Trench, Ft^2	500	262-708	500	276-1000
Depth of Gravel, In.	16	11-19	16	14-19
Depth of Ground Cover, Ft.	1.5	1.0-3.0	1.5	1.0-6.1

Less than 10 percent of the homes in each of the food waste grinder classes had dishwashers and less than 10 percent had water softeners, while practically all had washing machines. In every case they discharged to the septic tank system. A distribution of these appliances is shown in Table 12.

Table 12

Special Appliances
Wyandotte County, Kansas

Appliance	With Food Waste Grinder		Without Food Waste Grinder	
	No. With	No. Without	No. With	No. Without
Dishwasher	7	46	9	105
Water Softener	4	49	7	107
Washing Machine	51	2	105	9
Automatic	33		79	
Conventional	12		17	
History of Both	6		9	

Other Performance Affecting Factors.

A comparison between food waste grinder and non-food waste grinder systems in other factors that may affect performance is given in Table 13. More of the non-food waste grinder homes are in the older age and the greater person loadings groups. However, in all other respects there are no significant differences in the distribution of the factors.

Table 13

Comparison of Performance Affecting Factors
Wyandotte County, Kansas

Performance Affecting Factor	Median	Range	Mean	Difference*
Age, Yrs.				
With FWG	2.8	0.3-5.7	2.4	Significant
Without FWG	3.0	0.2-5.8	2.9	
Persons, No.				
With FWG	3.0	2.0-5.8	3.4	Not Significant
Without FWG	3.4	2.0-7.0	3.6	
Laundry Loads/Wk.				
With FWG	6	1-15	6.1	Not Significant
Without FWG	4	1-14	7.1	
Total Abs. Area, Ft^2				
With FWG	1166	502-1635	1139	Not Significant
Without FWG	1166	117-1865	1154	
Total Abs. Area/Person, Ft^2/Person				
With FWG	357	167-817	364	Not Significant
Without FWG	314	167-640	357	
Septic Tank Capacity, Gals.				
With FWG	810	250-1800	882	Not Significant
Without FWG	810	500-1650	854	
Septic Tank Capacity/Person, Gals./Person				
With FWG	270	65-625	277	Not Significant
Without FWG	250	94-635	265	

*At 95 percent level, based on a chi-square analysis of tabulated data.

Comparison of classes of systems according to alteration to topography, ground slope, and system layout is shown in Table 14. A greater number of systems in the food waste grinder category were in altered topography where some cut or fill was evident.

Table 14

Comparison of Topography and System Layouts
Wyandotte County, Kansas

Factor	Number of Systems			Difference
Topography	Altered	Unaltered		
With FWG	30	23		
Without FWG	44	70		Significant
Layout of System	Separate	Combined		
With FWG	17	36		
Without FWG	33	81		Not Significant
Ground Slope	0-2%	3-5%	>5%	
With FWG	33	14	6	
Without FWG	63	38	13	Not Significant

Gross Performance.

For a comparison of performance the data have been subdivided into combined-type systems and separate-type systems, and into systems in altered topography and unaltered topography. A summary of the gross performance of all systems by category is given in Table 15. On the basis of gross performance of all systems, the food waste grinder systems have a significantly

higher failure rate. Fifty of the total systems were of the separated type and there was no difference in performance between those with and without food waste grinders in this category. With respect to topography, most of the failures were in systems in altered ground with a greater percentage of failures in the with food waste grinders category.

Table 15

Gross Performance
Wyandotte County, Kansas

Class of System	Number of Observations				
	Satisfactory	Failed	Total	Percent Failed	Difference*
All Systems					
With FWG	37	16	53	30	
Without FWG	103	11	114	10	Significant
Separated Systems					
With FWG	16	1	17	6	
Without FWG	31	2	33	6	Not Significant
Combined Systems					
With FWG	21	15	36	42	
Without FWG	72	9	81	11	Significant
Altered Topography					
With FWG	16	14	30	47	
Without FWG	35	8	43	19	Significant
Unaltered Topography					
With FWG	21	2	23	9	
Without FWG	68	3	71	4	Not Significant

*At 95 percent level, based on a chi-square analysis of 4-fold tables.

Survival Curves.

A summary of data and the calculations for survival curves are shown in Table 16. The curves are presented on Figure 2. All of the systems on which complete data were available are included.

There appears to be a consistently lower survival of the food waste grinder systems over the full age span.

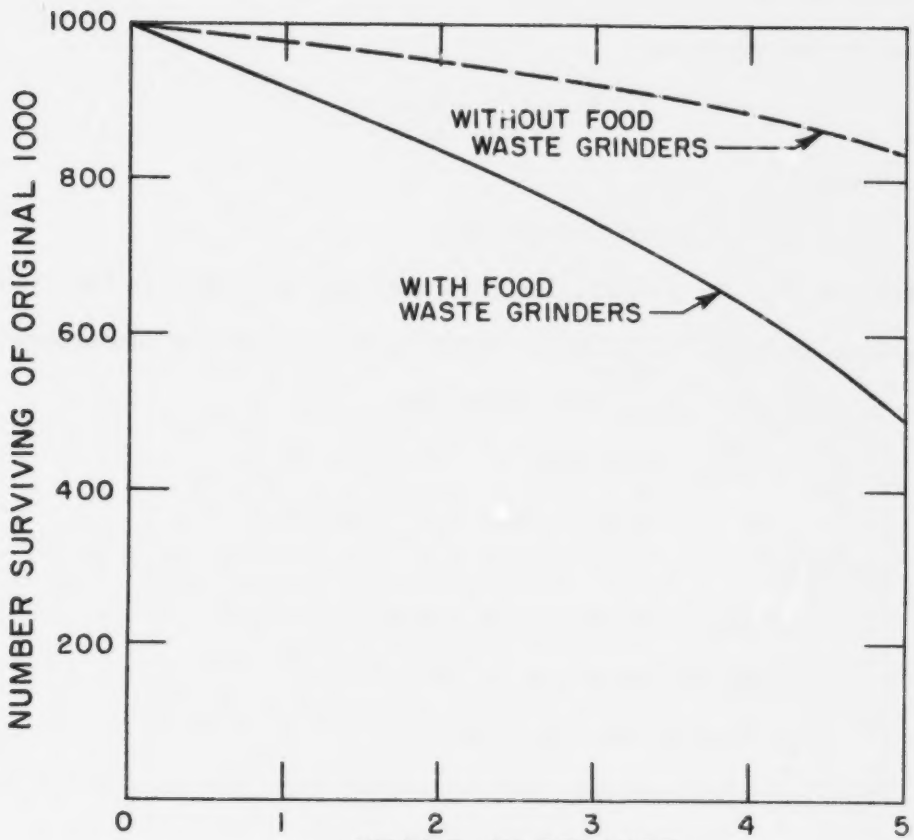
Table 16

Survival Curve Calculations
Wyandotte County, Kansas

Age of System	Number Reaching Age	Number Failed	q_x	l_x	d_x
		With Food Waste Grinders			
0-0.9	53	5	.094	1000	94
1.0-1.9	40	5	.125	906	113
2.0-2.9	29	3	.103	793	82
3.0-3.9	17	3	.176	711	125
4.0-4.9	5	0	.000	586	0
5.0-5.9	2	0	.000	586	0
		Without Food Waste Grinders			
0-0.9	114	4	.035	1000	35
1.0-1.9	98	2	.020	965	19
2.0-2.9	80	3	.038	946	36
3.0-3.9	51	1	.020	910	18
4.0-4.9	20	1	.050	892	45
5.0-5.9	5	0	.000	847	0

Soil Area Used.

Information on the amount of soil absorption area used was obtained in 19 detailed study cases; 8 with food waste grinders and 11 without food waste grinders. The basic data on age, persons, water use, soil area wetted, and apparent application rates are shown in Table 17.



SURVIVAL CURVES
WYANDOTTE COUNTY, KANSAS

FIGURE 2

Based on analyses developed in the Seepage Bed Report,* the relationship between the amount of absorption area wetted, A (square feet), for a given liquid loading, Q (cubic feet per year), in a given time, t (years), may be expressed by the equation:

$$A = \frac{Q}{kL} + \frac{Q}{L} t$$

where:

k and L are soil parameters.

Employing the average transmission rate analysis described in the cited report, and the data in Table 17, general design equations for the two classes of systems in Wyandotte County were developed:

With FWG $\quad A = .024\ Qt$

Without FWG $\quad A = .017\ Qt$

where:

A is soil area wetted in square feet,

Q is annual water use in cubic feet,

t is time of service in years.

The food waste grinder systems use about 60 percent greater absorption area than the non-food waste grinder systems.

Performance of soil absorption systems in Wyandotte County was somewhat poorer than would be expected from the relatively fast percolation rates obtained. This may be explained in part by the high percentage of systems in the area that were found in altered topography and the fact that systems in altered topography performed more poorly than those where no alteration had taken place.

*Study of Seepage Beds. Report to the Federal Housing Administration, Robert A. Taft Sanitary Engineering Center, December 15, 1960.

Table 17

Soil Absorption System Data
Detailed Studies
Wyandotte County, Kansas

System Number	Time in Service (Yrs.)	Persons (No.)	Total Area Used (Ft^2)	Water Use* $Ft^3/Yr.$	Apparent Application Rate $Ft^3/Ft^2/Yr.$	Reciprocal of Application Rate $Ft^2/Ft^3 \times Yrs.$
			With Food Waste Grinders			
2228	0.8	4.0	154	10,404	67.6	.015
2215	1.3	4.0	118	9,996	84.7	.012
2061	1.6	2.7	282	4,020	14.3	.070
2047	2.2	2.2	141	7,500	53.2	.019
2023	2.7	2.7	382	2,940	7.7	.129
2103	2.9	2.8	646	6,648	10.3	.097
2007	3.5	4.0	673	9,648	14.3	.070
2072	3.7	2.0	170	5,550	32.6	.031
Mean	2.3	3.1	321	7,088	35.6	.055
Std. Dev.	1.0	0.8	226	2,811	29.5	.043
			Without Food Waste Grinders			
2235	1.7	4.0	255	6,900.	27.1	.037
2171	2.7	4.3	256	8,076	31.5	.031
2029	2.9	2.0	488	9,204	18.9	.053
2082	3.0	4.7	983	9,804	10.0	.101
2071	3.1	2.0	215	2,604	12.1	.083
2243	3.1	4.9	256	7,920	30.9	.032
2238	3.4	4.0	353	8,400	23.8	.042
2028	3.5	3.5	326	5,532	17.0	.059
2113	3.9	3.0	82	4,728	57.7	.017
2180	4.6	2.7	377	9,072	24.1	.042
Mean	3.2	3.5	326	7,224	25.3	.050
Std. Dev.	0.9	1.0	256	2,287	13.5	.025

*Annual water use projected from average use during December, January, and February.

Scum and Sludge Accumulations.

Solids accumulations data were obtained in 21 detailed study cases, 9 with food waste grinders and 12 without food waste grinders. The basic data are shown in Table 19. A summary of the data is given in Table 18.

Table 18

Solids Accumulations
Wyandotte County, Kansas

Item	With Food Waste Grinder (9 Systems)		Without Food Waste Grinder (12 Systems)	
	Mean	Standard Deviation	Mean	Standard Deviation
Age, Yrs.	2.38	0.96	2.86	1.02
Person, No.	3.17	0.83	3.52	0.97
Septic Tank Capacity, Gals./Person	301	77	215	68
Solids Accumulations, Ft^3/Person/Yr.				
Scum	0.40	0.29	0.50	0.57
Sludge	6.29	4.99	3.11	2.97
Scum and Sludge	6.42	5.07	3.61	2.88

The food waste grinder systems were slightly younger and less heavily loaded in terms of person usage, but they had septic tanks of about 40 percent greater capacity per capita. In most of the septic tanks examined in Wyandotte County there was very little scum accumulation and the rate of accumulation was lower in the food waste grinder tanks; however, the rate of sludge accumulation was about 100 percent greater in the food waste grinder tanks.

Table 19

Septic Tank Data
Scum and Sludge Accumulations
Detailed Studies
Wyandotte County, Kansas

System Number	Time in Service (Yrs.)	Persons (No.)	Tank Capacity (Gals.)	Solids Accumulations (Ft^3)		
				Floating Scum	Submerged Scum	Sludge
			With Food Waste Grinders			
2228	1.0	4.0	1340	0.8	3.1	38.7
2215	1.3	4.0	950	0.0	0.0	88.0
2061	1.6	2.7	800	0.0	0.0	30.0
2047	2.1	2.2	790	0.0	0.0	31.7
2023	2.5	2.8	810	1.7	6.2	8.3
2014	2.9	4.0	780	0.0	0.0	21.6
2103	2.9	2.8	1110	2.6	3.9	62.0
2007	3.5	4.0	820	0.7	10.7	37.0
2072	3.7	2.0	800	0.0	0.0	20.7
			Without Food Waste Grinders			
2183	1.2	4.0	800	0.0	1.5	53.0
2225	1.3	3.1	780	0.0	0.0	1.1
2235	1.7	4.0	800	0.0	0.0	33.3
2171	2.7	4.3	490	4.1	8.7	6.4
2029	2.9	2.0	500	1.5	4.5	14.5
2082	3.0	4.7	910	0.0	0.0	40.1
2071	3.1	2.0	760	0.0	0.0	17.2
2243	3.1	4.9	1070	0.9	1.7	17.5
2238	3.4	4.0	740	5.4	15.0	27.3
2028	3.5	3.5	470	1.7	7.0	55.6
2113	3.9	3.0	790	0.2	0.2	52.5
2080	4.6	2.7	500	5.3	9.3	4.6

Polk County, Iowa

GENERAL INFORMATION

Climate.

Polk County is located in south central Iowa. The principal city, Des Moines, is the state capital as well as the county seat and the largest city in the state. The Des Moines metropolitan area contains about 90 percent of the total county population. In 1960 the total population was estimated at about 266,000.

The climate of Polk County is typical of the northern plains states. The area is in the eastern edge of the humid-climate belt bordering on the moist, subhumid-humid belt. Some of the more important climatic factors that may influence septic tank system performance are shown in Table 20. The average frost-free season is about 145 days. Annual potential evapotranspiration is about 27 inches. The climate is neither highly favorable nor unfavorable for septic tank systems.

Soils and Topography.

The topography is characterized by an even plain that has been dissected by stream erosion. The upland which is about 1000 feet above sea level is flat or gently undulating. Moderate to steep slopes exist along the streams and rivers. Surface drainage is generally good.

Table 20

Summary of Climatological Data
Polk County, Iowa*

Temperature, Precipitation, and Sunshine
for Years of Record from 1905 to 1960

Season	Temperature, °F			Precipitation, Inches			Percent of Possible Sunshine
	Mean	Mean Maximum	Mean Minimum	Mean Total	Driest Year	Wettest Year	
Annual	50	60	40	31	17	42	61
Winter (Dec.Jan.Feb.)	24	33	16	3.5	1.4	6.9	50
Summer (Jun.Jul.Aug.)	74	84	63	12	3.7	20	69

Temperature and Precipitation for
Years Preceding and During Survey

Dates	Mean Temperature, °F			Mean Precipitation, Inches		
	Annual	Winter	Summer	Annual	Winter	Summer
1950-59	50	25	74	28	3.0	11
1955-59	50	24	74	26	2.5	9.8
Oct.'58-Sept.'59	50	21	75	31	2.1	9.8

*Weather Bureau Station located in Des Moines, Iowa.

Soils* of the county fall into three general groups based on the parent material from which they have developed. Soils in the northern four-fifths of the county have developed on glacial drift of the Wisconsin age, and those in the southern one-fifth have developed on a loessial parent material. Relatively small areas of soil along the streams have developed from alluvium. The glacial soils are predominantly of the Clarion-Nicollet-Webster series with internal drainage ranging from well to poorly drained. The loessial soils are primarily of the Sharpsburg-Tama series and associated soils. Their internal drainage ranges from moderate to well drained. The alluvial soils occur as a complex mixture of several series and are generally in the poorly drained classification.

Health Department Organization and Septic Tank Practice.

The Polk County and Des Moines City Health Departments are combined under one administrative head. At the time of these studies the general sanitation staffs consisted of the chief and 11 sanitarians in the city and 3 sanitarians in the county. Very few septic tank installations are being made within the city. The county sanitarians devote approximately 40 percent of their time to septic tank control. Organized control of septic tank installations has existed since about 1939. The city and county operate under the rules and regulations of the Iowa State Department of Health. The first regulations adopted July 1, 1941 required a 350-gallon septic tank and a minimum of 144 lineal feet of 18-inch wide trench. The minimum septic tank

*Soil Survey of Polk County, Iowa. U. S. Department of Agriculture, Bureau of Soils, 1921. Also from personal communication with the State Soil Scientist of Iowa.

size was increased to 500 gallons in July 1949. Regulations of the state, county, and city have been gradually increased, and at present the minimum septic tank capacity is 750 gallons and the amount of tile field required is determined from the results of percolation tests.

RESULTS OF FIELD STUDIES

Field work commenced in Polk County in May 1959 and was completed in October 1959. Investigations were concentrated in two general areas, a contiguous group of subdivisions in West Des Moines in the western part of the county and the Wakonda area southwest of Des Moines.

Survey Area Descriptions.

The Wakonda survey area is approximately seven miles southwest of the Des Moines business section. The area consists of a number of small subdivisions and numerous homes on individual building sites. General surveys were conducted at 80 out of a total of about 250 homes in the area. Ages range from less than one to about 10 years. There is a wide range in size of homes and in the estimated market prices.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	40	28	12
Without FWG	40	30	10

The West Des Moines survey area is approximately six miles west of the Des Moines business section. This area includes 12 subdivisions with a total of about 350 homes of which 300 were surveyed. Ages of the homes range from less than one to about 18 years, with about 75 percent being less than 5 years old. The homes are predominantly of the three-bedroom size and are estimated as selling from $17,000 to $30,000 on the present market.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	165	139	26
Without FWG	135	117	18

Soils Descriptions.

All cases surveyed in the Wakonda area were in soil classified as Downs silt loam. The soil is well drained and has developed from medium textured loess. A representative profile is as follows:

0"-9" Very dark grayish brown medium granular silt loam.

9"-33" Dark yellowish brown silt loam with a subangular blocky structure and a few slight mottles.

33"+ Light yellowish brown friable massive "light" silty clay loam with some slight mottling.

Since no detailed studies were conducted in the Wakonda area, percolation tests were not made in the Downs soil.

The great majority of soils at homes surveyed in the West Des Moines area are classified as Clarion loam and mixtures of the Clarion, Dickinson, and Lester series. These soils are well drained and have developed from late Wisconsin glacial till. A representative profile for the Clarion loam is as follows:

0"-10" Very dark brown to very dark grayish brown friable medium granular loam.

10"-30" Dark brown to brown subangular blocky loam.

30"+ Yellowish brown to dark yellowish brown friable massive loam, calcareous.

Percolation tests conducted in accordance with the Manual of Septic Tank Practice were made at five sites. The results of these tests are given in Table 21.

Table 21

Percolation Test Results
Polk County, Iowa

Number of Test Sites	Number of Test Holes	Percolation Rate (Min./In.)		
		Average	Standard Deviation	Range
5	30	13.2	15.4	2.3-75

Construction and Loading.

Construction and loading characteristics of the soil absorption systems surveyed in Polk County are shown in Table 22. Since the soils in the two survey areas were very similar in their drainage characteristics, the data have been combined for the analyses that follow.

Table 22

Construction and Loading
Polk County, Iowa

Factor	With Food Waste Grinder (205 Systems)		Without Food Waste Grinder (175 Systems)	
	Median	Range	Median	Range
Age of System, Yrs.	3.0	0.2-12.2	4.7	0.7-18.1
Persons/Home, No.	3.3	1.0-10.1	3.0	1.6-11.1
Septic Tank Capacity, Gals.	1000	250-1650	750	250-1650
Width of Trench, In.	20	12-34	18	12-48
Length of Trench, Ft.	220	140-475	200	100-470
Bottom Area of Trench, Ft^2	381	200-1000	300	28-785
Depth of Gravel, In.	12	9-20	12	7-48
Depth of Ground Cover, Ft.	1.6	1.0-3.0	1.6	0.6-6.5

The distribution of other household appliances which might have a bearing on system performance is given in Table 23. The homes with food waste grinders have a higher percentage of dishwashers and water softeners; however, there was no significant difference in failure rates at homes with or without these other appliances. About half of the water softeners in each category discharge the regeneration liquid to the soil system. Practically all of the homes have washing machines, with a higher proportion of automatic washers in the food waste grinder homes.

Table 23

Special Appliances
Polk County, Iowa

Appliances	With Food Waste Grinder		Without Food Waste Grinder	
	No. With	No. Without	No. With	No. Without
Dishwasher	72	133	7	168
Water Softener	150	55	71	104
Washing Machine	200	5	166	9
Automatic	184		124	
Conventional	8		21	
History of Both	8		21	

Other Performance Affecting Factors.

A comparison between food waste grinder and non-food waste grinder systems in other factors that may affect performance is given in Table 24. More non-food waste grinder homes are in the higher age groups, but they have significantly smaller septic tanks and absorption areas provided. There is no significant difference in the average persons and laundry loads.

Table 24

Comparison of Performance Affecting Factors
Polk County, Iowa

Performance Affecting Factor	Median	Range	Mean	Difference*
Age, Yrs.				
With FWG	3.0	0.2-12.2	3.3	Significant
Without FWG	4.7	0.7-18.1	5.6	
Persons, No.				
With FWG	3.3	1.0-10.1	3.7	Not Significant
Without FWG	3.0	1.6-11.0	3.7	
Laundry Loads/Wk.				
With FWG	8.0	1-35	8.5	Not Significant
Without FWG	8.0	1-30	8.5	
Total Abs. Area, Ft^2				
With FWG	844	442-2209	864	Significant
Without FWG	704	138-1800	729	
Total Abs. Area/Person, Ft^2/Person				
With FWG	241	90-783	269	Significant
Without FWG	204	58-900	218	
Septic Tank Capacity, Gals.				
With FWG	1000	250-1650	948	Significant
Without FWG	750	250-1650	697	
Septic Tank Capacity/Person, Gals./Person				
With FWG	250	93-825	288	Significant
Without FWG	208	73-500	217	

*At 95 percent level, based on a chi-square analysis of tabulated data.

Comparison of classes of systems according to alteration to topography and ground slope is shown in Table 25. There is no significant difference between the distribution of the food waste grinder and the non-food waste grinder systems according to alteration to topography or to ground slope.

Table 25

Comparison of Topography
Polk County, Iowa

Factor	Number of Systems			Difference
Topography	Altered	Unaltered		
With FWG	39	166		
Without FWG	28	147		Not Significant
Ground Slope	0-2%	3-5%	>5%	
With FWG	79	67	59	
Without FWG	62	59	54	Not Significant

Gross Performance.

A comparison of gross performance as shown in Table 26 indicates no significant difference between the with and without food waste grinder systems. However, it should be pointed out that the food waste grinder systems had about 20 percent greater absorption area provided and about 40 percent larger septic tanks, while the non-food waste grinder systems are significantly older.

Table 26

Gross Performance
Polk County, Iowa

Class of System	Number of Observations				
	Satisfactory	Failed	Total	Percent Failed	Difference*
All Systems					
With FWG	167	38	205	18.5	Not Significant
Without FWG	147	28	175	16.0	
Altered Topography					
With FWG	34	5	39	12.8	Not Significant
Without FWG	25	3	28	10.7	
Unaltered Topography					
With FWG	133	33	166	19.9	Not Significant
Without FWG	122	25	147	17.0	

*At 95 percent level, based on a chi-square analysis of 4-fold tables.

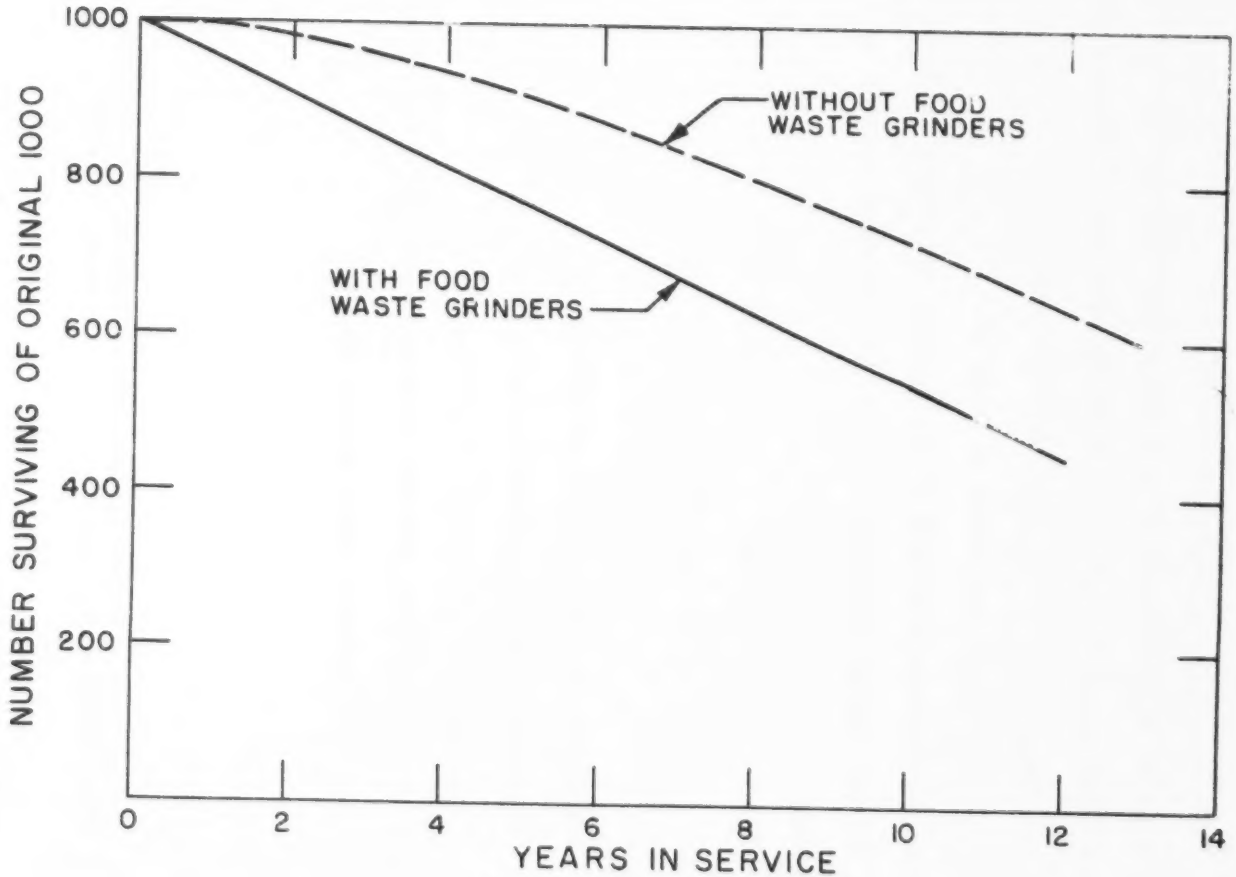
Survival Curves.

A summary of data and calculations for survival curves is shown in Table 27. The curves are shown on Figure 3. A consistently lower survival over the full age range is indicated for the food waste grinder systems.

Table 27

Survival Curve Calculations
Polk County, Iowa

Age of System	Number Reaching Age	Number Failed	q_x	l_x	d_x
		With Food Waste Grinders			
0-0.9	205	6	.029	1000	29
1.0-1.9	181	4	.022	971	21
2.0-2.9	146	14	.096	950	91
3.0-3.9	97	7	.072	859	62
4.0-4.9	45	3	.067	797	53
5.0-5.9	30	2	.067	744	50
6.0-6.9	19	0	.000	694	0
7.0-7.9	11	1	.091	694	63
8.0-8.9	6	0	.000	631	0
9.0-9.9	5	1	.200	631	126
10.0-10.9	1	0	.000	505	0
11.0-11.9	1	0	.000	505	0
12.0-12.9	1	0	.000	505	0
		Without Food Waste Grinders			
0-0.9	173	2	.011	1000	11
1.0-1.9	166	3	.018	989	18
2.0-2.9	151	4	.026	971	25
3.0-3.9	130	1	.008	946	8
4.0-4.9	99	4	.040	938	38
5.0-5.9	75	3	.040	900	36
6.0-6.9	64	4	.062	864	54
7.0-7.9	46	1	.022	810	18
8.0-8.9	32	3	.094	792	74
9.0-9.9	16	1	.062	718	45
10.0-10.9	9	1	.011	673	7
11.0-11.9	6	0	.000	666	0
12.0-12.9	4	1	.250	666	166
13.0-13.9	1	0	.000	500	0



SURVIVAL CURVES
POLK COUNTY, IOWA

FIGURE 3

Soil Area Used.

Information on the amount of soil absorption area used was obtained in 32 detailed study cases, 17 with food waste grinders and 15 without food waste grinders. The basic data on age, persons, water use, soil area wetted, and apparent application rates are shown in Table 28.

Based on analyses developed in the Seepage Bed Report* and the data in Table 28, general design equations for the two classes of systems in Polk County were developed:

With FWG $A = .0066\ Qt$

Without FWG $A = .0049\ Qt$

where:

A is the soil area wetted in square feet,

Q is the annual water use in cubic feet,

t is the time of service in years.

The food waste grinder systems developed about 35 percent greater total wetted area than the non-food waste grinder systems.

*Study of Seepage Beds. Report to the Federal Housing Administration, Robert A. Taft Sanitary Engineering Center, December 15, 1960.

Table 28

Soil Absorption System Data
Detailed Studies
Polk County, Iowa

System Number	Time in Service (Yrs.)	Persons (No.)	Total Area Used (Ft^2)	Water Use* $Ft^3/Yr.$	Apparent Application Rate $Ft^3/Ft^2/Yr.$	Reciprocal of Application Rate $Ft^2/Ft^3 \times Yrs.$
			With Food Waste Grinders			
4044	1.1	3.0	38	12,846	333.3	.003
4153	1.3	5.0	63	10,942	175.7	.006
4118	1.4	5.0	91	11,789	130.0	.008
4279	1.7	5.0	138	7,993	58.2	.017
4053	2.0	4.0	102	10,301	101.0	.010
4198	2.9	3.0	68	7,701	113.8	.009
4150	2.9	2.0	168	4,929	29.4	.034
4151	2.9	4.0	297	8,009	26.1	.037
4062	3.0	4.2	133	6,361	47.9	.021
4297	3.8	3.0	64	4,948	77.1	.013
4183	3.8	3.0	334	7,163	21.6	.046
4255	3.8	2.0	120	6,746	56.2	.018
4161	3.9	4.0	86	14,765	172.4	.006
4130	4.0	3.9	216	6,309	29.2	.034
4239	4.4	2.0	103	3,627	31.8	.032
4274	4.6	4.3	208	8,304	39.9	.025
4106	7.8	1.3	206	4,031	19.6	.051
Mean	3.3	3.5	143	8,045	86.1	.022
Std. Dev.	1.6	1.2	76	3,150	81.6	.015
			Without Food Waste Grinders			
4099	2.2	3.0	79	6,203	78.9	.013
4167	2.3	3.1	79	7,685	97.2	.010
4235	2.3	2.0	33	4,757	145.0	.007
4230	2.8	5.7	242	14,328	59.2	.017
4117	2.8	3.5	32	7,977	245.0	.004
4181	3.2	4.0	96	5,409	56.4	.017
4048	3.3	5.0	162	7,261	44.9	.022
4054	3.4	3.8	316	8,830	27.9	.036
4050	3.7	4.2	310	11,005	35.4	.027
4165	3.9	7.1	200	7,439	37.1	.027

Table 28 (Continued)

Soil Absorption System Data
Detailed Studies
Polk County, Iowa

System Number	Time in Service (Yrs.)	Persons (No.)	Total Area Used (Ft^2)	Water Use* $Ft^3/Yr.$	Apparent Application Rate $Ft^3/Ft^2/Yr.$	Reciprocal of Application Rate $Ft^2/Ft^3 \times Yrs.$
			Without Food Waste Grinders (Continued)			
4184	4.0	3.0	101	7,030	69.6	.014
4013	4.4	4.7	74	13,286	179.3	.006
4160	5.0	3.5	155	8,172	52.7	.019
4175	5.6	4.6	56	7,394	132.0	.008
4113	7.1	4.1	448	11,355	25.3	.040
Mean	3.7	4.1	159	8,542	86.7	.018
Std. Dev.	1.4	1.2	120	2,760	63.5	.011

*In Polk County water meters were read on a quarterly basis. The water use reported here is winter water use (October-November-December and January-February-March) projected to a 12-month basis.

Scum and Sludge Accumulations.

The basic solids accumulations data for 32 detailed study cases are shown in Table 30. A summary of the data is given in Table 29.

The food waste grinder systems are slightly younger and less heavily loaded in terms of persons, but have about 30 percent greater per capita tank capacity than the non-food waste grinder systems. The rates of scum and sludge accumulation are significantly greater in the food waste grinder tanks. Scum is about 76 percent greater and sludge about 48 percent greater. The combined accumulation rate is about 54 percent greater.

Table 29

Solids Accumulations
Polk County, Iowa

Item	With Food Waste Grinder (17 Systems)		Without Food Waste Grinder (15 Systems)	
	Mean	Standard Deviation	Mean	Standard Deviation
Age, Yrs.	3.25	1.62	3.73	1.36
Person, No.	3.44	1.15	4.09	1.24
Septic Tank Capacity, Gals./Person	309	99	234	103
Solids Accumulations, Ft^3/Person/Yr.				
Scum	1.41	1.02	0.80	0.62
Sludge	4.73	2.74	3.18	1.65
Scum and Sludge	6.14	2.78	3.98	1.61

Table 30

Septic Tank Data
Scum and Sludge Accumulations
Polk County, Iowa

System Number	Time in Service (Yrs.)	Persons (No.)	Tank Capacity (Gals.)	Solids Accumulations (Ft^3)		
				Floating Scum	Submerged Scum	Sludge
With Food Waste Grinders						
4044	1.1	3.0	980	0.2	1.4	28.3
4153	1.3	5.0	990	0.9	3.3	47.6
4118	1.4	5.0	1050	3.0	7.9	25.1
4279	1.7	5.0	990	1.6	6.4	57.4
4053	2.0	4.0	1010	0.3	1.3	49.0
4198	2.9	3.0	1000	3.9	20.1	87.5
4150	2.9	2.0	1020	1.5	8.8	7.3
4151	2.9	4.0	1100	7.6	30.3	59.3
4062	3.0	4.2	1030	0.0	4.0	87.1
4297	3.8	3.0	800	5.5	14.2	26.8
4183	3.8	3.0	990	1.0	4.6	80.9
4255	3.8	2.0	1060	2.4	7.1	14.1
4161	3.9	4.0	970	1.6	5.5	23.9
4130	4.0	3.9	1040	5.1	19.7	64.6
4239	4.4	2.0	780	1.0	9.4	12.1
4274	4.6	4.3	1140	16.5	52.6	68.8
4106	7.8	1.3	520	5.3	15.1	31.2
Without Food Waste Grinders						
4099	2.2	3.0	1021	0.0	0.0	30.8
4167	2.3	3.2	970	3.8	5.2	18.5
4235	2.3	2.0	1060	0.2	0.0	30.6
4230	2.8	5.7	1010	3.0	15.0	87.5
4117	2.8	3.5	980	0.0	3.6	21.2
4181	3.2	4.0	790	1.1	3.0	55.0
4048	3.3	5.0	980	4.2	15.5	69.1
4054	3.4	3.8	1000	1.6	8.4	20.2
4050	3.7	4.2	720	2.6	10.2	64.2
4165	3.9	7.1	800	0.5	4.1	68.3
4184	4.0	3.0	760	7.1	18.1	31.6
4013	4.4	4.7	800	8.2	23.3	59.8
4160	5.0	3.5	500	4.5	15.1	23.1
4175	5.6	4.6	800	0.0	4.6	40.5
4113	7.1	4.1	800	7.6	25.4	32.6

Tarrant County, Texas

GENERAL INFORMATION

Climate.

Tarrant County occupies an area of 877 square miles in north central Texas. It is bounded on the east by Dallas County in which studies were also conducted. Population of the county in 1960 was approximately 540,000. Ft. Worth, the county seat and largest city, has a population of approximately 356,000.

The county is in the extreme north portion of the humid-subtropical region that extends northward from the Gulf of Mexico. The climate is characterized by moderate rainfall, abundant sunshine, mild temperatures, and low humidity. A summary of some of the climatic factors that may influence the performance of soil absorption systems is given in Table 31.

The recent climate of Tarrant County was characterized by a drought period from 1951 through 1956 when precipitation was about 25 percent below normal. The drought was broken in 1957 when one of the wettest years on record was experienced.

The first killing frost can be expected about November 21 and the last about March 14. On the average there are 252 days of growing season, ranging from 197 to 291 days. Annual potential evapotranspiration is estimated as about 40 inches.

Table 31

Summary of Climatological Data
Tarrant County, Texas*

Temperature, Precipitation, and Sunshine
for Years of Record from 1905 to 1960

Season	Temperature, °F			Precipitation, Inches			Percent of Possible Sunshine
	Mean	Mean Maximum	Mean Minimum	Mean Total	Driest Year	Wettest Year	
Annual	66	76	55	32	18	51	64
Winter (Dec.Jan.Feb.)	48	58	37	5.8	2.2	18.9	53
Summer (Jun.Jul.Aug.)	83	94	73	7.3	0.2	18.0	73

Temperature and Precipitation for
Years Preceding and During Survey

Dates	Mean Temperature, °F			Mean Precipitation, Inches		
	Annual	Winter	Summer	Annual	Winter	Summer
1950-59	66	49	85	29	4.5	5.4
1955-59	66	47	84	33	4.6	6.1
Jul.'58-Jun.'59	65	45	84	31	3.1	13.0

*Weather Bureau Station located in Ft. Worth, Texas.

Soils and Topography.

Tarrant County is traversed by four north-south belts, each distinguished from the adjoining belt by differing native vegetation and soil. The belts from west to east are the West Cross Timbers, Grand Prairie, East Cross Timbers, and Black Prairie. Topography ranges from deeply dissected sections having steep hills and deep ravines in the western belt to the relatively smooth Black Prairie in the east. The area is underlain by clays and sands in the west and alternating limestones, marls, and shales going towards the east.

The soils in Tarrant County range in color from deep black to gray, and in texture from sand to heavy clay. The soils are primarily of the Houston-Austin-Denton group.* They tend to be shallow and lacking in a definite soil profile development.

The rolling hills of the area generally range from about 400 to 900 feet in elevation. The maximum elevation of 940 feet occurs in the west central part of the county, while the lowest point of about 420 feet is in the channel of the West Fork of the Trinity River. The entire drainage of the county is into the Trinity River.

Health Department Organization and Septic Tank Practice.

Tarrant County Health Department is under the direction of a full-time health officer. The general sanitation staff consists of a sanitary engineer and three sanitarians, with the engineer and one sanitarian devoting about 30 percent of their time to septic tank control.

*Soil Survey of Tarrant County, Texas. U. S. Department of Agriculture, Bureau of Soils, 1920.

Control and enforcement of septic tank regulations are secured through the Texas General Sanitation Law of 1945. Inspection of septic tank installations is provided by the health department only upon request. These requests usually originate with various mortgage insuring agencies and lending institutions.

Design and construction of septic tank systems have been generally based on FHA Minimum Property Requirements. Approximately 95 percent of all septic tanks installed are of precast concrete. They are vertical cylinders in shape with two or more tanks connected in series and have total liquid capacities ranging from 500 to 1000 gallons. Two-compartment tanks are the most common.

Soil absorption systems are the shallow, narrow-trench type. Distribution boxes are used extensively, but tees and wyes are occasionally used as distributor devices. "Land block" or serial distribution systems are often used on sloping ground.

A variety of system layouts is permitted, ranging from a combined system of one septic tank and one absorption system to separate systems for the kitchen, bathroom, and laundry wastes.

RESULTS OF FIELD STUDIES

Field work commenced on the food waste grinder study in Tarrant County in February 1959. Since that was the initial site for these studies it served to develop procedures and techniques for selecting specific subdivisions for study. Health department records, food waste grinder manufacturers' and distributors' records, and home builders' records proved fruitless for this purpose. It finally became necessary to make a preliminary canvass of each potential study location. This preliminary canvass was conducted either by telephone or on-site interviews. Three subdivisions were ultimately selected in the Tarrant County area: North Richland Hills, Edgecliff Village, and Van Zandt Development.

Subdivision Descriptions.

North Richland Hills subdivision is in the northern part of the county. The total subdivision consists of about 3000 homes. A sewering program has been under way in the area since 1955. Some of the homes surveyed had recently connected to the sewers. The homes range from 8 to 10 years in age, are of brick construction, have large yards, and are well maintained. It was estimated that the price of the homes would be in the $10,000 to $16,000 range.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	5	4	1
Without FWG	69	43	26

Edgecliff Village, located in the southern part of the county, consists of approximately 100 homes ranging in age from four to six years. Homes are judged to be in the $20,000 to $35,000 price range and are located on large lots. Few health department records existed for this area, and all information was obtained from homeowner interviews and direct observations.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	15	10	5
Without FWG	30	17	13

Van Zandt Development, located in the northeast section of the county, consists of approximately 100 homes. Topography is steeply rolling with many systems on greater than six percent slope. House prices are estimated in the $20,000 to $25,000 range.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	2	2	0
Without FWG	4	4	0

Soils Descriptions.

The San Saba series of the Houston-Austin-Denton soil group was the predominant soil in each of the subdivisions. These soils have developed from limestone marls or chalks. The surface soils are dark gray to black in color, and silty clay to clay in texture to a depth of about two feet. The subsoils are brown to yellow clay. Parent material is encountered at from two to six feet.

Percolation tests conducted in accordance with the Manual of Septic Tank Practice were made at two representative sites. The results are shown in Table 32.

Table 32

Percolation Test Results
San Saba Soil
Tarrant County, Texas

Number of Test Sites	Number of Test Holes	Percolation Rate (Min./In.)		
		Average	Standard Deviation	Range
2	11	34	36	3-100

Construction and Loading.

Construction and loading characteristics of the systems observed in Tarrant County, classified by food waste grinder usage, are shown in Table 33.

In some cases the kitchen and bathroom wastes were disposed of into separate systems. In these cases measurements on the combined facility were used in the table. Twenty-nine of the 125 systems were the separated type, 6 in the food waste grinder homes and 23 in the non-food waste grinder homes.

All of the homes had washing machines, mostly the automatic type, and 99 percent were discharged to the soil systems. None of the homes had water softeners. Fourteen of the food waste grinder homes had dishwashers, while only 25 of the non-food waste grinder homes were so equipped.

Table 33

Construction and Loading
Tarrant County, Texas

Factor	With Food Waste Grinder (22 Systems)		Without Food Waste Grinder (103 Systems)	
	Median	Range	Median	Range
Age of System, Yrs.	4.3	1.4-8.2	5.7	0.5-10.7
Persons/Home, No.	3.9	1.8-6.0	3.9	1.5-7.0
Septic Tank Capacity, Gals.	625	500-1250	500	500-1000
Width of Trench, In.	18	12-28	18	9-24
Length of Trench, Ft.	273	183-423	250	128-381
Bottom Area of Trench, Ft^2	415	180-705	375	158-669
Depth of Gravel, In.	12	10-12	12	7-15
Depth of Ground Cover, Ft.	2.6	1.9-3.0	2.2	1.1-3.0

Other Performance Affecting Factors.

The use of food waste grinders is only one of several factors that may affect the performance of septic tank systems. A bias produced by any one or a combination of other factors could produce misleading results. By confining surveys to individual subdivisions within the jurisdiction of a single local health department, the chances of maintaining equality of such factors as control practices, construction techniques, and climatic conditions were enhanced. To investigate the possibility of bias by other factors, analyses were made to compare the distribution of other performance affecting factors between food waste grinder systems and non-food waste grinder systems. A summary of these analyses is shown in Table 34. The distribution of ages and the distribution of person loads and laundry uses are not significantly different for the two classes of systems. However, the food waste grinder

systems had larger absorption areas and greater septic tank capacities both on a gross and a per capita basis.

Table 34

Comparison of Performance Affecting Factors
Tarrant County, Texas

Performance Affecting Factor	Median	Range	Mean	Difference*
Age, Yrs.				
With FWG	4.3	1.4-8.2	4.5	Not Significant
Without FWG	5.7	0.9-10.7	5.6	
Persons, No.				
With FWG	3.9	1.8-6.0	3.7	Not Significant
Without FWG	3.9	1.5-7.0	3.7	
Laundry Loads/Wk.				
With FWG	6	2-21	7.6	Not Significant
Without FWG	6	2-22	7.0	
Total Abs. Area, Ft^2				
With FWG	990	646-1551	953	Significant
Without FWG	875	448-1350	826	
Total Abs. Area/Person, Ft^2/Person				
With FWG	204	72-647	297	Significant
Without FWG	223	125-469	241	
Septic Tank Capacity, Gals.				
With FWG	625	500-1250	718	Significant
Without FWG	500	500-1000	529	
Septic Tank Capacity/Person, Gals./Person				
With FWG	238	83-500	236	Significant
Without FWG	135	74-333	154	

*At 95 percent level, based on a chi-square analysis of tabulated data.

A comparison of the systems on the basis of alteration to topography, ground slope, and layout of the system is shown in Table 35. The two classes of systems are comparable in these respects.

Table 35

Comparison of Topography and System Layouts
Tarrant County, Texas

Factor	Number of Systems			Difference
Topography	Altered		Unaltered	
With FWG	1		21	
Without FWG	0		103	Not Significant
Layout of System	Separate		Combined	
With FWG	6		16	
Without FWG	23		80	Not Significant
Ground Slope	0-2%	3-5%	>5%	
With FWG	11	3	2	
Without FWG	78	10	2	Not Significant

Gross Performance.

For the purpose of comparison of gross performance, the data were classified into combined-type systems and separated-type systems. The combined systems were further screened of systems that had been recently sewered at the time of the survey. While a history of septic tank system performance was available for these recently sewered homes, it depended solely on information from the home occupant and could not be verified by field investigators. To avoid the possibility of bias, these systems were

considered separately. A summary of gross performance for the various categories is shown in Table 36. The differences in gross performance of food waste grinder and non-food waste grinder systems are not significant in any one of the classifications, neither is there a significant difference between the performance of the combined and separated type systems.

Table 36

Gross Performance
Tarrant County, Texas

Class of System	Number of Observations				
	Satisfactory	Failed	Total	Percent Failed	Difference*
All Systems					
With FWG	16	6	22	27	
Without FWG	64	39	103	38	Not Significant
Separated Systems					
With FWG	4	2	6	33	
Without FWG	11	12	23	52	Not Significant
Combined Systems					
With FWG	12	4	16	25	
Without FWG	53	27	80	33	Not Significant
Combined Systems on Septic Tanks at Time of Survey					
With FWG	12	4	16	25	
Without FWG	52	13	65	20	Not Significant

*At 95 percent level, based on a chi-square analysis of 4-fold tables.

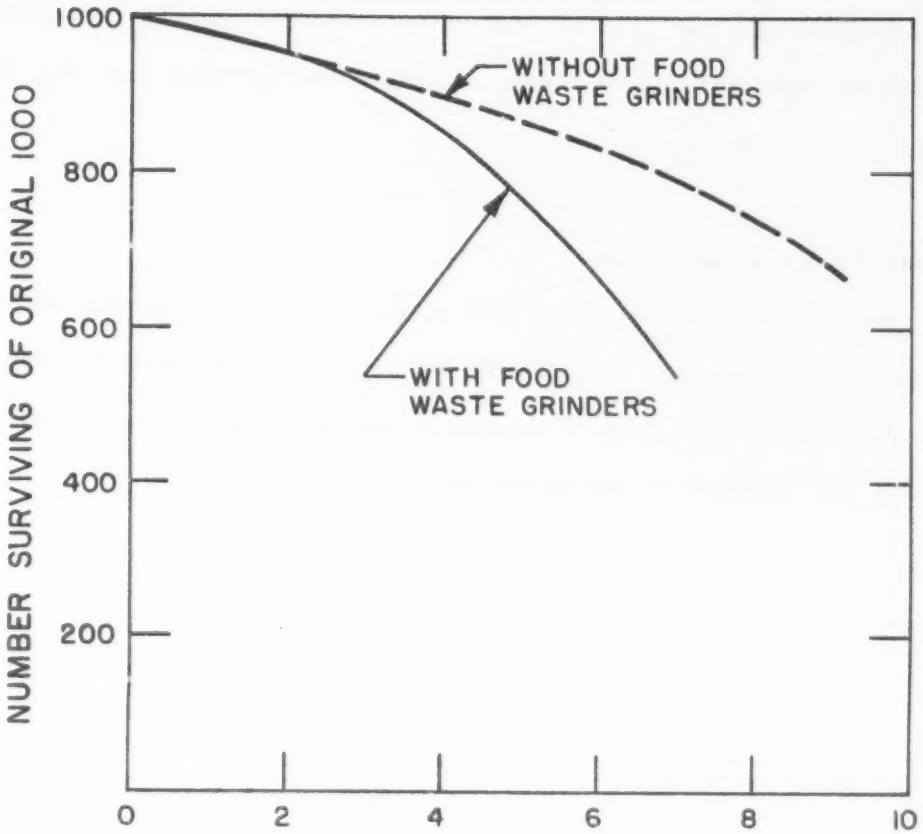
Survival Curves.

Calculations for mortality-type survival curves are shown in Table 37. The curves are plotted on Figure 4. The data include only those homes that were on combined systems and still on septic tanks at the time of the survey. The curves indicate a somewhat greater die-off of the food waste grinder systems after about three years of life.

Table 37

Survival Curve Calculations
Tarrant County, Texas

Age of System	Number Reaching Age	Number Failed	q_x	l_x	d_x
		With Food Waste Grinders			
0-0.9	16	0	.000	1000	0
1.0-1.9	16	1	.062	1000	62
2.0-2.9	14	0	.000	938	0
3.0-3.9	11	1	.091	938	93
4.0-4.9	7	1	.143	853	0
5.0-5.9	5	1	.200	731	168
6.0-6.9	3	0	.000	585	0
7.0-7.9	1	0	.000	585	0
		Without Food Waste Grinders			
0-0.9	65	3	.046	1000	46
1.0-1.9	62	1	.016	954	15
2.0-2.9	58	3	.052	939	49
3.0-3.9	53	2	.038	890	34
4.0-4.9	47	1	.021	856	18
5.0-5.9	43	1	.023	838	19
6.0-6.9	25	0	.000	819	0
7.0-7.9	6	1	.167	819	137
8.0-8.9	3	0	.000	682	0
9.0-9.9	2	0	.000	682	0
10.0-10.9	2	1	.500	682	341



SURVIVAL CURVES
TARRANT COUNTY, TEXAS

FIGURE 4

Soil Area Used.

Detailed studies on soil absorption systems were conducted at four homes, two with and two without food waste grinders. Since these data are insufficient for analyses by themselves, they are included with the Dallas section of the report.

Scum and Sludge Accumulations.

Solids accumulations data were obtained for two cases for each class of system. The data are insufficient for meaningful analyses by themselves. Since the climate and soils of Tarrant County are similar to Dallas County, the data are combined in the Dallas section of the report.

Dallas County, Texas

GENERAL INFORMATION

Climate.

Dallas County lies in north central Texas. It is bounded on the east by Tarrant County in which studies were also conducted. Population of the county in 1960 was approximately 952,000. Dallas, the county seat and largest city, has a population of about 680,000.

The area is in the extreme north portion of the subtropical belt, extending northward from the Gulf of Mexico. Some of the climatic factors that may influence septic tank system performance are given in Table 38. As with Tarrant County, the recent climate has been influenced by a drought period during the early 1950's which ended in 1957 with an extremely wet year.

The first killing frost is expected late in November and the last about the middle of March. The growing season extends over about 250 days. Annual potential evapotranspiration is estimated at about 40 inches.

Soils and Topography.

The topography may be characterized as a broad, rolling prairie dissected by numerous streams that have cut broad, shallow valleys. Ground elevation ranges between 500 and 700 feet above sea level. Surface drainage is through the Trinity River and its tributaries. The drainage is adequate over the uplands but the broad, shallow valleys are subject to ponding and overflow.

Table 38

Summary of Climatological Data
Dallas County, Texas*

Temperature, Precipitation, and Sunshine
for Years of Record from 1913 to 1960

Season	Temperature, °F			Precipitation, Inches			Percent of Possible Sunshine
	Mean	Mean Maximum	Mean Minimum	Mean Total	Driest Year	Wettest Year	
Annual	66	76	56	35	22	49	66
Winter (Dec.Jan.Feb.)	48	47	38	7.1	2.3	15	50
Summer (Jun.Jul.Aug.)	84	93	74	7.3	0.4	18	77

Temperature and Precipitation for
Years Preceding and During Survey

Dates	Mean Temperature, °F			Mean Precipitation, Inches		
	Annual	Winter	Summer	Annual	Winter	Summer
1951-60	66	48	85	34	6.0	5.7
1956-60	66	47	85	38	7.6	6.4
Jun.'59-May '60	64	46	83	43	12	8

*Weather Bureau Station located in Dallas, Texas.

Dallas County lies within the region known as the Black Prairie.* The soils have developed from underlying marls and chalk with small areas of shale. Soils range in color from deep black to gray, with textures predominantly clay or heavy clay loam. The soils are classified in the Houston-Austin-Denton group. Depth ranges from less than two feet to several feet. During the wetter seasons water tends to collect in pockets in the bedrock creating a complex pattern of local shallow water tables.

Health Department Organization and Septic Tank Practice.

Two independent health departments exercise control of septic tank systems within the county, the City of Dallas Health Department and the Dallas County Health Department. Both departments are well organized and competently staffed.

Due to expansion of the Dallas city limits many of the areas within the city that are using septic tanks were in the county at the time of installation of the systems. It was, therefore, necessary to utilize records of both health departments in developing the study in Dallas County. The areas finally selected for survey come within the present jurisdiction of the city health department.

Control and enforcement of septic tank regulations in the county jurisdiction are secured through the Texas General Sanitation Law of 1945. Permits are not required and inspection is provided only upon request.

*Soil Survey of Dallas County, Texas. U. S. Department of Agriculture, Bureau of Soils, 1924.

Ordinance control of septic tank systems within city jurisdiction extends back to about 1941. At that time a septic tank with a minimum capacity of 300 gallons was required. The minimum was increased to 500 gallons in 1958. Actual installations have generally been above the minimum requirement. In 1951 the minimum size acceptable absorption system was a trench 16 inches in width and a total of 150 feet in length. In 1958 the trench width was increased to 24 inches. As with the septic tank, actual installations have generally been above the minimum.

From 1949 through 1954 percolation tests were conducted by the health department for subdivision control. System requirements were related to FHA Minimum Property Standards in effect at that time. Percolation testing was discontinued in 1954, except when needed to supplement general soils information.

Practically all septic tanks installed since 1941 have been precast vertical cylinders with capacities ranging from 150 to 300 gallons. An installation generally consists of two, three, or four individual tanks in series for a total capacity of about 1000 gallons.

RESULTS OF FIELD STUDIES

Field work was conducted in Dallas County from April through August 1959 and from November 1959 through May 1960. The two periods of study enabled field teams to conduct observations during the hot, dry period when conditions were at the optimum for system performance and during the wetter, winter period when ground water conditions could have affected performance adversely.

Studies were concentrated in two contiguous subdivisions in the northeastern part of the county, Walnut Hills subdivision and Midway subdivision. A total of 495 general survey cases and 43 detailed study cases were obtained.

Subdivision Descriptions.

Walnut Hills subdivision consists of approximately 500 homes of which 411 were surveyed. Age of the homes ranges from less than one year to more than eight years with most of the homes in the four- to six-year range. Homes are of brick construction and are mostly of the three-bedroom size. Price of the homes on the present market was estimated to range from $20,000 to $40,000.

The area is gently rolling and has good surface drainage. Except for the addition of four to six inches of top soil in most of the yards to establish lawns very little cut or fill has been made.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	345	324	21
Without FWG	66	64	2

Midway subdivision adjoins Walnut Hills subdivision on the east. It contains about 170 homes of which 84 were surveyed. The homes are somewhat smaller than those in Walnut Hills. They are predominantly of the two-bedroom size with ages ranging from 2 to 11 years. The price class of the homes is also somewhat lower, ranging from $8,000 to $14,000. Soils and topography of Midway subdivision are similar to those in Walnut Hills.

Type of System	Number of Systems Surveyed	Satisfactory	Failed
With FWG	4	3	1
Without FWG	80	70	10

Soils Descriptions.

The principal soils in both subdivisions are in the Houston-Austin-Denton group. A recent unpublished soils map of the area shows the predominant series as Austin or Houston with deep and shallow phases intermixed. These soils have developed from chalk or marl and are highly calcareous. Internal drainage is moderately good to poor. A generalized profile is as follows:

0"-10" Dark brown to black heavy plastic clay.

10"+ Generally lighter in color but of same heavy texture, grading into firmly weathered chalk or marl at two to six feet.

A detailed soil survey based on soil depth was made for the two subdivisions. Soils were classified as: shallow, less than two feet to parent material; medium, two to three feet to parent material; and deep, greater than three feet to parent material.

Percolation tests conducted according to the Manual of Septic Tank Practice were made at 6 sites and are summarized in Table 39.

Table 39

Percolation Test Results
Dallas County, Texas

Number of Test Sites	Number of Test Holes	Percolation Rate (Min./In.)		
		Average	Standard Deviation	Range
6	35	105	71	8-250

Construction and Loading.

Construction and loading characteristics of septic tank-soil absorption systems in Dallas County are shown in Table 40. The systems with food waste grinders are larger and younger than the systems without food waste grinders.

Table 40

Construction and Loading
Dallas County, Texas

Factor	With Food Waste Grinder (349 Systems)		Without Food Waste Grinder (146 Systems)	
	Median	Range	Median	Range
Age of System, Yrs.	4.2	0.3-7.3	6.1	0.1-11.2
Persons/Home, No.	4.0	1.8-13.0	3.7	1.0-6.0
Septic Tank Capacity, Gals.	810	250-1000	500	250-1000
Width of Trench, In.	30	24-48	30	24-48
Length of Trench, Ft.	295	175-375	200	18-375
Bottom Area of Trench, Ft^2	750	450-934	531	300-875
Depth of Gravel, In.	16	16-17	16	16-16
Depth of Ground Cover, Ft.	Not Recorded			

The use of special appliances is shown in Table 41. Very few of the homes had water softeners, while practically all had automatic sequence washers. Practically all of the food waste grinder homes had dishwashers, while less than half of the non-food waste grinder homes were so equipped. There was no significant difference in failure rates at homes with or without dishwashers.

Table 41

Special Appliances
Dallas County, Texas

Appliance	With Food Waste Grinder		Without Food Waste Grinder	
	No. With	No. Without	No. With	No. Without
Dishwasher	336	13	58	88
Water Softener	3	346	2	144
Washing Machine	335	14	119*	18*
Automatic	335		115	
Conventional	0		1	
History of Both	0		3	

*Washing machine data not available on all systems without food waste grinders.

Other Performance Affecting Factors.

A comparison between systems with and without food waste grinders in factors which most obviously might influence performance is shown in Table 42. The food waste grinder systems are significantly younger, and have greater absorption areas and septic tank capacities provided, all of which should favor their better performance over non-food waste grinder systems. The food waste grinder systems are more heavily loaded in terms of persons.

Table 42

Comparison of Performance Affecting Factors
Dallas County, Texas

Performance Affecting Factor	Median	Range	Mean	Difference*
Age, Yrs.				
With FWG	4.2	0.3-7.3	4.1	Significant
Without FWG	6.1	0.1-11.2	6.4	
Persons, No.				
With FWG	4.0	1.8-13.0	4.2	Significant
Without FWG	3.7	1.0-6.0	3.5	
Laundry Loads/Wk., No.				
With FWG	8	1-36	8.8	Not Significant
Without FWG	7	1-18	7.1	
Total Abs. Area, Ft^2				
With FWG	1550	930-1860	1510	Significant
Without FWG	1050	567-1808	1180	
Total Abs. Area/Person, Ft^2/Person				
With FWG	362	231-904	392	Significant
Without FWG	340	142-990	356	
Septic Tank Capacity, Gals.				
With FWG	810	250-1000	820	Significant
Without FWG	500	250-1000	591	
Septic Tank Capacity/Person, Gals./Person				
With FWG	193	58-500	212	Significant
Without FWG	167	45-500	187	

*At 95 percent level, based on a chi-square analysis of tabulated data.

The distribution of systems according to topography is shown in Table 43. There is no significant difference in the two classes of systems in either alteration to topography or slope of the ground surface over the systems.

Table 43

Comparison of Topography
Dallas County, Texas

Factor	Number of Systems			Difference
Topography	Altered		Unaltered	
With FWG	2		347	Not Significant
Without FWG	1		146	
Ground Slope	0-2%	3-5%	>5%	
With FWG	264	84	1	Not Significant
Without FWG	120	25	1	

Gross Performance.

For a comparison of performance the data have been separated according to depth of soil. A summary of the gross performance of all systems by soil type is given in Table 44.

Table 44

Gross Performance
Dallas County, Texas

Soil Type	Number of Observations: Satisfactory	Failed	Total	Percent Failed	Difference*
All Systems					
With FWG	327	22	349	6.3	Not Significant
Without FWG	134	12	146	8.2	
Shallow Soil					
With FWG	151	9	160	5.6	Not Significant
Without FWG	44	1	45	2.2	
Medium Soil					
With FWG	59	1	60	1.7	Not Significant
Without FWG	40	8	48	16.7	
Deep Soil					
With FWG	117	12	129	9.3	Not Significant
Without FWG	50	3	53	5.7	

*At 95 percent level, based on chi-square analysis of 4-fold tables.

Survival Curves.

A summary of data and calculations for curves is shown in Table 45. The curves are presented in Figure 5. Meaningful curves could not be constructed by soil depth because of the few numbers of failures in some categories. Based on the total samples, there appears to be no difference in the performance of systems with and without food waste grinders. However, it should be remembered that based on mean values the without food waste grinder systems had about

40 percent greater bottom absorption areas provided and about 40 percent larger septic tanks. Apparently these increased capacities were sufficient to provide for comparable performance of food waste grinder systems.

Table 45

Survival Curve Calculations
Dallas County, Texas

Age of System	Number Reaching Age	Number Failed	q_x	l_x	d_x
		With Food Waste Grinders			
0-0.9	349	5	.014	1000	14
1.0-1.9	337	5	.015	986	15
2.0-2.9	311	7	.021	971	20
3.0-3.9	264	3	.011	951	10
4.0-4.9	198	2	.010	941	9
5.0-5.9	87	0	.000	932	0
6.0-6.9	19	0	.000	932	17
7.0-7.9	2	0	.000	915	0
		Without Food Waste Grinders			
0-0.9	146	2	.014	1000	14
1.0-1.9	143	0	.000	986	0
2.0-2.9	142	2	.014	986	14
3.0-3.9	137	2	.014	972	14
4.0-4.9	127	4	.031	958	30
5.0-5.9	105	1	.010	928	9
6.0-6.9	73	0	.000	919	0
7.0-7.9	30	1	.033	919	30
8.0-8.9	10	0	.000	889	0
9.0-9.9	4	0	.000	889	0
10.0-10.9	2	0	.000	889	0
11.0-11.9	1	0	.000	889	0

Soil Area Used.

Information on the amount of soil absorption area used was obtained in 43 detailed study cases, 22 with food waste grinders and 21 without food waste grinders. The basic data on age, persons, water use, soil area wetted, and apparent application rates are shown in Table 46. The data are separated according to depth of soil in which the system was installed. Shallow soils are those in which the depth to underlying rock is two feet or less, medium soil is two to three feet, and deep soil greater than three feet.

Based on analyses developed in the Seepage Bed Report,* the amount of absorption area wetted, A (square feet), for a given annual water use, Q (cubic feet per year), in a given time, t (years), may be expressed by the equation:

$$A = \frac{Q}{kL} + \frac{Q}{L} t$$

where:

k and L are soil parameters.

Employing the average transmission rate approach described in the above-cited report and the data for all soils in Table 46, the average area wetted relationships for the two classes of systems in Dallas County may be expressed as:

With FWG $\quad A = .0060\ Qt$

Without FWG $\quad A = .0055\ Qt$

where:

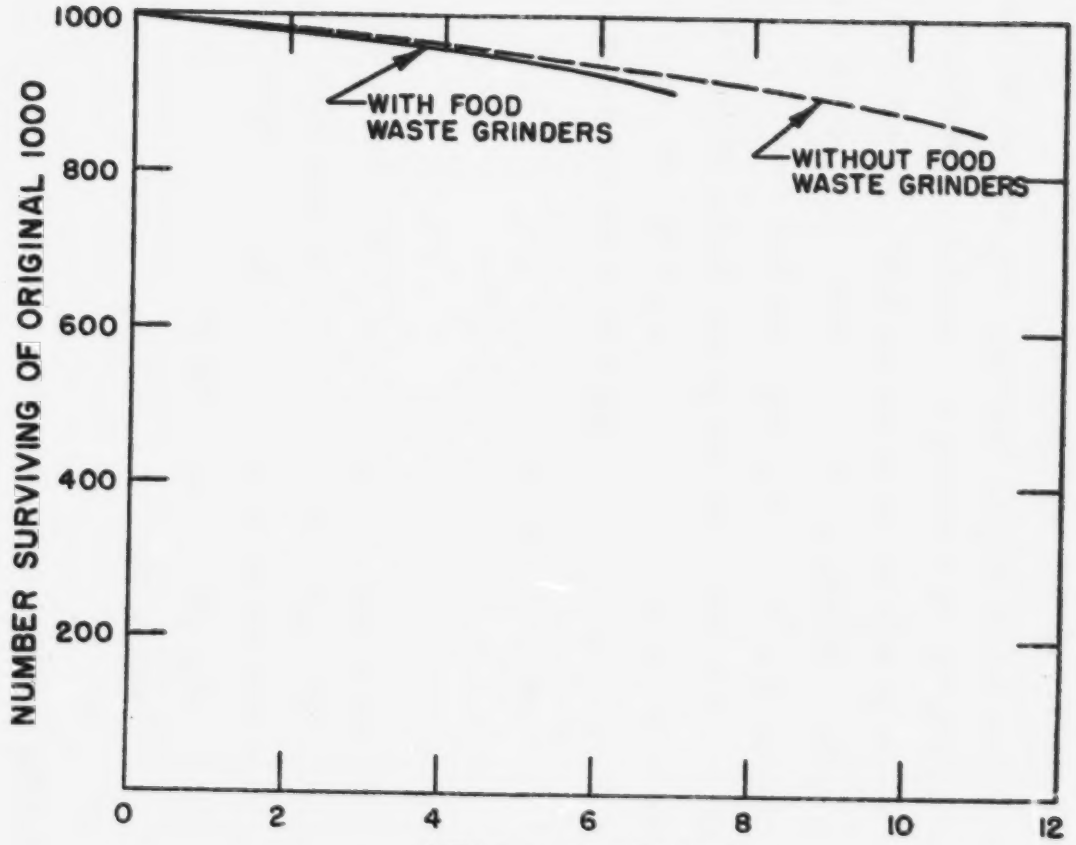
A is total area wetted in square feet,

Q is annual water use in cubic feet,

t is time of service in years.

The food waste grinder systems have used about 10 percent more total absorption area than the non-food waste grinder systems.

*Study of Seepage Beds. Report to the Federal Housing Administration, Robert A. Taft Sanitary Engineering Center, December 15, 1960.



SURVIVAL CURVES
DALLAS COUNTY, TEXAS

FIGURE 5

In spite of the relatively slow percolation rates observed in the Dallas soils, performance of soil absorption systems was good. This discrepancy may be explained in part by the extreme shrinking and swelling these soils undergo with varying moisture contents. During that portion of the study conducted during the summer months, it was observed that as the soils dried many large cracks and extraneous channels developed throughout the profile. It was not unusual for the large cracks to extend down to the underlying parent material. These conditions were observed even under good sod coverings. It is not improbable that such cracks resulted in increased opportunity for soil absorption system aeration and subsequent increased moisture losses through evaporation and transpiration. The cracks on occasion may have also led to a physical draining of partially ponded systems and, in effect, partially rejuvenated the clogged soil interfaces and thus resulted in better performance of systems than would normally be expected.

Table 46

Soil Absorption System Data
Detailed Studies
Dallas County, Texas

System Number	Time in Service (Yrs.)	Persons (No.)	Total Area Used (Ft^2)	Water Use $Ft^3/Yr.$	Apparent Application Rate $Ft^3/Ft^2/Yr.$	Reciprocal of Application Rate $Ft^2/Ft^3 \times Yrs.$
			With Food Waste Grinders			
Shallow Soil						
178	4.1	4.2	592	10,375	17.5	.057
168	4.8	4.0	419	15,274	36.5	.027
180	5.2	5.0	506	11,338	22.4	.045
179	5.3	3.5	480	16,332	34.0	.029
21	5.5	5.0	171	20,002	117.0	.008
369	5.5	3.0	656	6,230	9.5	.105
159	5.6	4.6	75	17,077	22.8	.004
Mean	5.1	4.2	414	13,802	37.1	.040
Std. Dev.	0.5	0.8	215	4,690	36.4	.034
Medium Soil						
31	3.2	6.0	83	15,362	18.5	.005
42	5.1	4.0	216	9,556	44.3	.023
14	6.8	5.0	248	13,727	55.5	.018
8	6.9	4.0	328	10,722	32.7	.031
2	7.0	5.4	297	16,001	53.9	.019
36	7.0	5.4	482	10,018	20.8	.048
Mean	6.0	5.0	276	12,564	37.6	.024
Std. Dev.	1.6	0.8	132	2,824	16.1	.014

Table 46 (Continued)

Soil Absorption System Data
Detailed Studies
Dallas County, Texas

System Number	Time in Service (Yrs.)	Persons (No.)	Total Area Used (Ft^2)	Water Use $Ft^3/Yr.$	Apparent Application Rate $Ft^3/Ft^2/Yr.$	Reciprocal of Application Rate $Ft^2/Ft^3 \times Yrs.$
With Food Waste Grinders (Continued)						
Deep Soil						
122	2.9	5.4	285	8,734	30.6	.033
312	4.2	4.0	237	11,632	47.9	.021
113	4.4	4.9	364	11,712	32.2	.031
108	4.7	7.0	605	20,301	33.6	.030
110	5.0	4.0	387	14,098	36.4	.028
409	2.6	4.6	205	10,429	51.0	.020
380	5.8	3.4	153	14,162	92.6	.011
142	6.4	4.7	525	14,589	27.8	.036
6	7.4	4.8	462	13,761	29.8	.034
Mean	4.8	4.8	358	13,269	42.4	.027
Std. Dev.	1.6	1.0	152	3,278	20.5	.008
Shallow, Medium, and Deep Soils Combined						
Mean	5.2	4.6	353	13,246	39.4	.030
Std. Dev.	1.4	0.9	173	3,544	24.6	.021
Without Food Waste Grinders						
Shallow Soil						
44	5.0	3.1	130	9,556	73.5	.014
130	5.4	3.6	382	13,113	34.3	.029
502	6.3	3.8	106	14,369	135.5	.007
544	7.0	2.0	490	6,631	59.7	.074
532	7.6	4.0	207	4,621	22.3	.045
Mean	6.3	3.3	263	9,660	65.1	.034
Std. Dev.	1.1	0.8	167	4,140	44.3	.027

Table 46 (Continued)

Soil Absorption System Data
Detailed Studies
Dallas County, Texas

System Number	Time in Service (Yrs.)	Persons (No.)	Total Area Used (Ft^2)	Water Use $Ft^3/Yr.$	Apparent Application Rate $Ft^3/Ft^2/Yr.$	Reciprocal of Application Rate Ft^2/Ft^3 x Yrs.
Without Food Waste Grinders (Continued)						
Medium Soil						
132	4.8	4.6	247	19,826	80.0	.012
133	5.3	4.0	499	12,494	25.0	.040
511	6.4	4.6	100	7,359	73.6	.014
7	7.0	4.0	472	21,862	46.4	.022
Mean	5.9	4.3	330	15,385	56.2	.022
Std. Dev.	1.0	0.3	190	6,683	25.4	.013
Deep Soil						
515	3.7	2.0	98	1,953	19.9	.050
362	3.7	4.0	546	16,222	29.5	.034
569	4.5	4.0	368	15,214	41.3	.024
121	4.8	4.4	181	13,734	75.9	.013
287	5.4	5.4	132	13,413	101.6	.010
264	5.6	3.6	157	18,847	120.0	.008
286	5.8	2.2	292	10,974	37.6	.027
139	6.0	5.9	508	9,413	18.5	.054
348	6.0	5.0	286	21,692	75.8	.013
145	6.1	5.1	363	12,514	34.5	.029
144	6.2	4.0	229	22,515	98.3	.010
524	7.8	4.0	505	8,620	17.1	.059
Mean	5.5	4.1	305	13,759	55.8	.028
Std. Dev.	1.2	1.2	155	5,784	36.6	.018
Shallow, Medium, and Deep Soils Combined						
Mean	5.7	4.0	300	13,092	58.1	.028
Std. Dev.	1.1	1.0	157	5,735	35.2	.015

Scum and Sludge Accumulations.

Solids accumulations data were obtained in 34 detailed study cases, 18 with food waste grinders and 16 without food waste grinders. Two cases in each category were obtained in adjoining Tarrant County. These data are combined and shown in Table 48. A summary is given in Table 47.

Table 47

Solids Accumulations
Dallas and Tarrant Counties, Texas

Item	With Food Waste Grinder (20 Systems)		Without Food Waste Grinder (18 Systems)	
	Mean	Standard Deviation	Mean	Standard Deviation
Age, Yrs.	4.85	1.14	5.60	1.10
Person, No.	4.61	0.91	3.70	1.14
Septic Tank Capacity, Gals./Person	170	47	201	68
Solids Accumulations, Ft^3/Person/Yr.				
Scum	0.86	0.40	0.59	0.28
Sludge	1.01	0.44	1.11	0.63
Scum and Sludge	1.87	0.58	1.70	0.56

The food waste grinder systems are younger and more heavily loaded. The per capita tank capacities are not significantly different. The scum accumulation rate of the food waste grinder tanks is about 45 percent greater than the non-food waste grinder tanks. The sludge accumulation rates are not significantly different.

Table 48

Septic Tank Data
Scum and Sludge Accumulations
Detailed Studies
Dallas and Tarrant Counties, Texas

System Number	Time in Service (Yrs.)	Persons (No.)	Tank Capacity (Gals.)	Solids Accumulations (Ft^3)		
				Floating Scum	Submerged Scum	Sludge
			With Food Waste Grinders			
122	2.9	5.4	920	6.0	12.5	12.6
31	3.2	6.0	690	7.3	25.8	20.6
178	4.1	4.2	710	4.9	15.6	13.3
312	4.2	4.0	950	5.7	11.2	12.1
113	4.4	4.9	970	2.6	5.0	29.0
108	4.7	7.0	970	4.3	9.0	40.3
168	4.8	4.0	1010	6.5	19.8	15.7
110	5.0	4.0	940	4.1	19.7	18.6
42	5.1	4.0	750	1.0	2.4	32.8
180	5.2	5.0	540	2.3	11.3	33.5
179	5.3	3.5	680	2.7	11.5	14.1
409	5.4	4.6	770	5.9	12.6	29.6
21	5.5	5.0	690	3.8	15.7	22.4
369	5.5	3.0	790	5.1	19.2	39.2
159	5.6	4.6	650	1.1	10.4	12.6
14	6.2	5.0	570	3.8	20.0	31.1
142	6.4	4.7	680	5.5	15.8	33.6
36	7.0	5.4	740	3.9	14.9	21.6
18*	2.5	4.0	490	2.9	2.6	8.2
24*	4.1	4.0	490	3.8	16.1	6.5

Table 48 (Continued)

Septic Tank Data
Scum and Sludge Accumulations
Detailed Studies
Dallas and Tarrant Counties, Texas

System Number	Time in Service (Yrs.)	Persons (No.)	Tank Capacity (Gals.)	Solids Accumulations (Ft^3)		
				Floating Scum	Submerged Scum	Sludge
Without Food Waste Grinders						
515	3.7	2.0	560	0.3	1.8	10.1
362	3.7	4.0	930	4.0	3.3	42.7
121	4.8	4.4	750	4.2	15.0	18.8
132	4.8	4.6	920	4.0	8.4	14.6
44	5.2	3.1	820	1.5	7.9	10.0
133	5.3	4.0	750	3.0	10.6	21.7
264	5.6	3.6	810	3.9	11.8	19.3
286	5.8	2.2	780	7.8	8.3	15.6
139	6.0	5.9	790	4.4	14.2	23.0
145	6.1	5.1	780	6.4	18.5	21.7
172	6.1	3.5	750	0.6	3.7	22.9
502	6.3	3.8	480	3.2	11.3	24.2
511	6.4	4.6	540	2.5	13.9	17.2
506	6.8	2.0	480	1.6	1.1	26.1
544	7.0	2.0	580	0.2	1.6	30.5
7	7.0	4.0	640	8.0	16.3	22.6
20*	6.6	3.0	490	4.7	8.6	14.2
25*	3.7	4.8	490	2.2	9.8	16.3

*Tarrant County cases, all other cases from Dallas County.

Data Forms

FOOD WASTE GRINDER - PRELIMINARY SURVEY NO.____

Notes: _____

_____

_____ Survey Date _____

Reported By _____ County _____ Ref. No. _____

(1) Lot No. _____ Builder _____ 1st Occupancy date _____

Address _____ Phone _____ From To Years

(2) Present Occupant _____ ____ ____ ____

Previous Occupant _____ ____ ____ ____

Previous Occupant _____ ____ ____ ____

(3) Dates: H.D. _____ Tax _____ Bldg. Permit _____ H_2O turn on _____

(4) System: Pits _____ Beds _____ Trenches _____ Others _____

(5) Calculated Age of Home _____ yrs. Determined Age of Failure _____

INFORMATION FROM HOUSE OWNER

(6) Size of Family: Adults Children Dates of Childrens' Births Pt

Present ____ ____ _____ ____

Yrs. on System ____ ____ _____

Previous ____ ____ _____ ____

Yrs. on System ____ ____ _____

Previous ____ ____ _____ ____

Yrs. on System ____ ____ _____ Total ____

(7) Size of Home: Rooms _____ Bedrooms _____ Bathrooms _____

Toilets _____ Wash Basins _____ Tubs _____ Showers _____ T & S Comb. ____

Laundry Trays _____ Conv. Washer _____ Auto. Washer _____ Dryer _____

(8) Other Waste Drains to System:

Basement _____ Roof _____ Foundation _____ Garage _____ Others _____

(9) Water Use: City ____ Private Well ____ Cistern ____ Others _____

Brands of Soap Brands of Detergents Box/Month Size

Laundry _____ _____ _____ ____

Kitchen _____ _____ _____ ____

INFORMATION FROM HOUSE OWNER

(10)

Appliance	No.	Make or Type	Model	Dates of Use From	Dates of Use To	Years	Amt. of Use (No./week)
Food Grinder							
Washer							
Dryer Condensing							
Dishwasher							
H_2O Softener							

(Regeneration details) _____

Note appliances not connected to system _____

_____

(11) Tank Cleanings (No. and Dates) _____

_____

(12) Has the system created a nuisance or failed to function properly? Noticed any odors at the start of use? Any seepage in yard? Dates of occurrences.

_____

_____

_____

_____

_____

(13) Changes in system (What and When)? _____

_____

_____

_____

_____

(14) Will owner permit digging up of the system? _____

FROM HEALTH DEPARTMENT RECORD

(15) Septic tank cap._____gals. Shape_____Compartments_____

Material: Conc., Others_____Mfg._____Date Inst._____

(16) Inspection Dates: Layout_____Final_____Others_____

(17) Absorption System:

Total Length___ft., Width___ft., Bottom Area___ft^2, No. of Trenches___

Depth____ft., Diameter____ft., Lining type_____

Type of gravel: Limestone, Natural, Slag, Others_____

Sizes of gravel: 0 1 2 3 4 to 0 1 2 3 4 inches

Gravel Depth: above tile_____in., below tile_____in.,

total_____in., ground cover_____ft.

(18) Dist. Box____, T's____, Y's____Others_____

(19) Soil data Percolation test result Augured - 1 sq. ft.

Hole No. 1 2 3 4 5 6

Rate

Description of soil_____

_____

Depth: to water table_____ft., to rock_____ft.

OBSERVATION OF SYSTEM

(20) Cut_____Fill_____Slope over system_____%

(21) Vegetation (Locate on sketch)

Bare____Lawn____Shrubs____Trees____Other_____

(22) Has system failed? (describe)_____

_____

_____

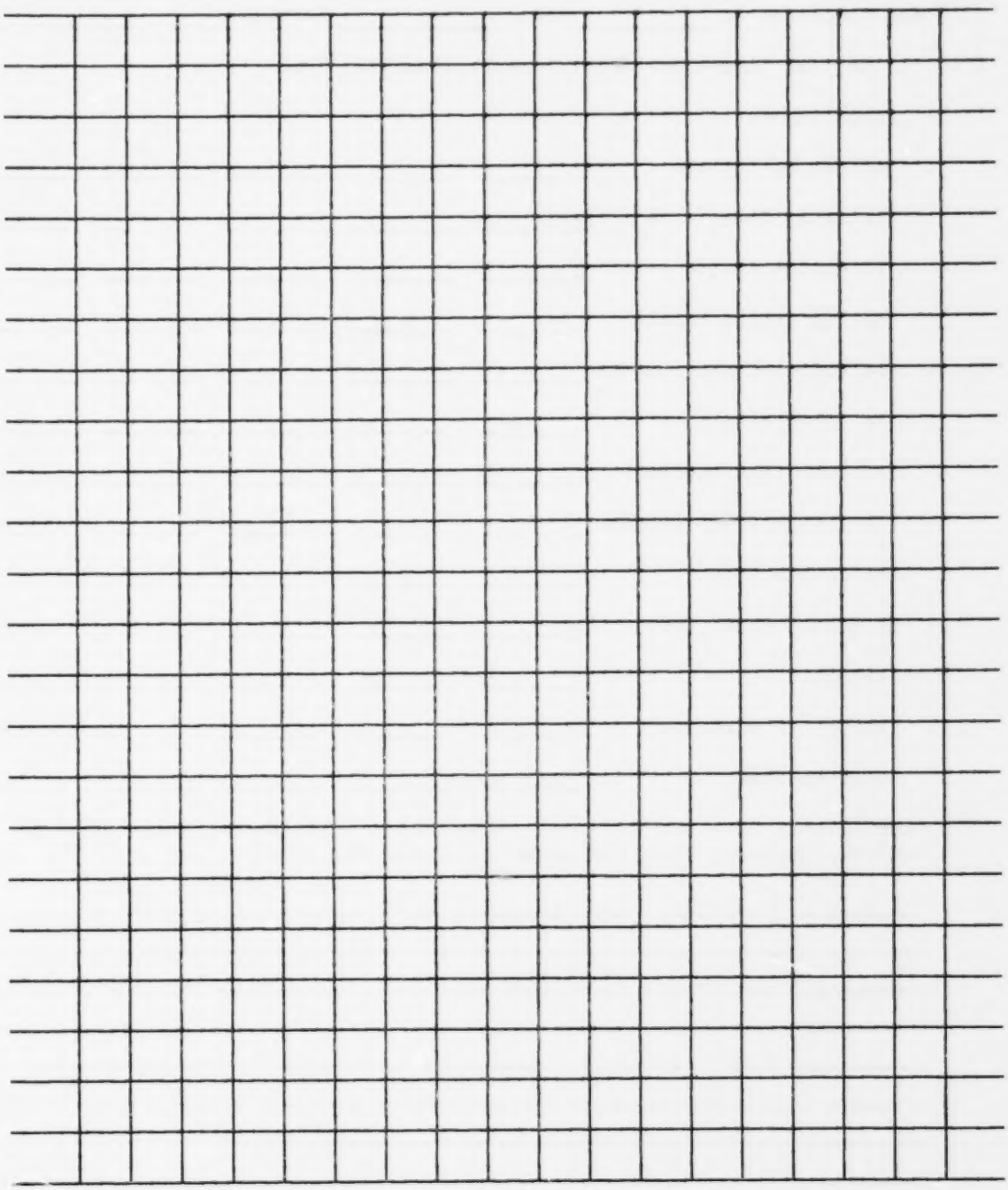
_____

_____

_____

_____

Include: Layout, dimensions, slopes, vegetation, seepage, soils and topography (fill and cuts, depressions, slopes).



FOOD WASTE GRINDER - DETAIL SURVEY

Ref. No._____

SEPTIC TANK MEASUREMENTS

(23) No. Compartments_____ Shape_____ Material_____

(24) Inside Tank Dimensions (Measurements from Wall Top)

Compartments:	1	2	3	4	5
to Ground Surface					
to Water Level					
to Outlet Invert					
to Top Outlet Baffle					
to Bottom Outlet Baffle					
to Inlet Invert					
to Top Inlet Baffle					
to Bottom Inlet Baffle					
to Bottom Tank					
Liquid Volume, Calc.					
Length					
Width (or diameter)					
Surface Area					

(25) Condition of Tank and Contents. (Structural condition of tank, inlets, outlets, baffles; characteristics of sludge and scum)

_____

_____

_____

_____

_____

_____

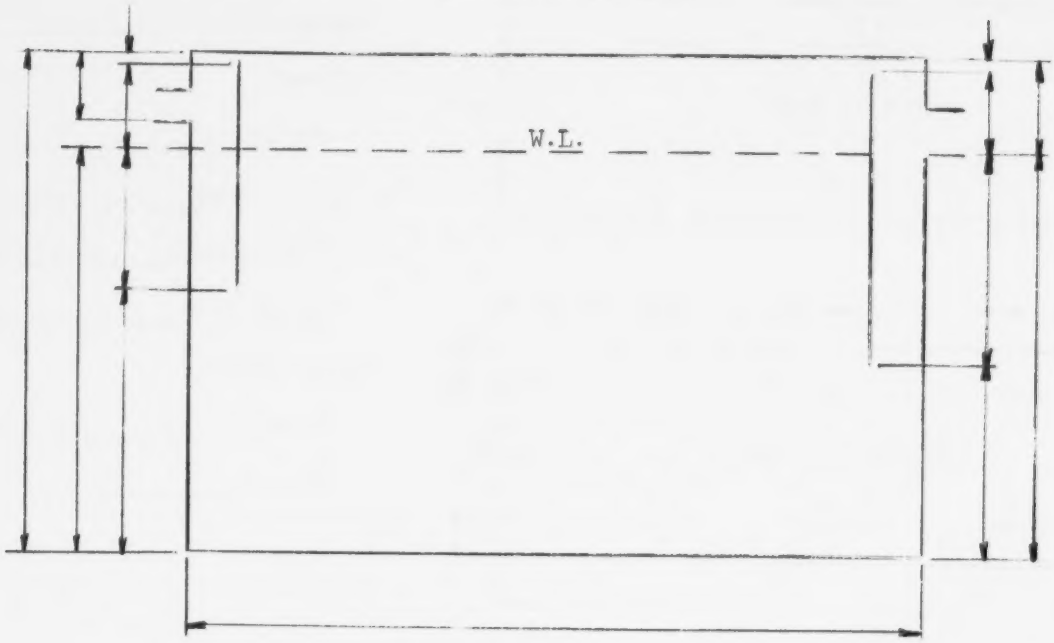
_____

_____

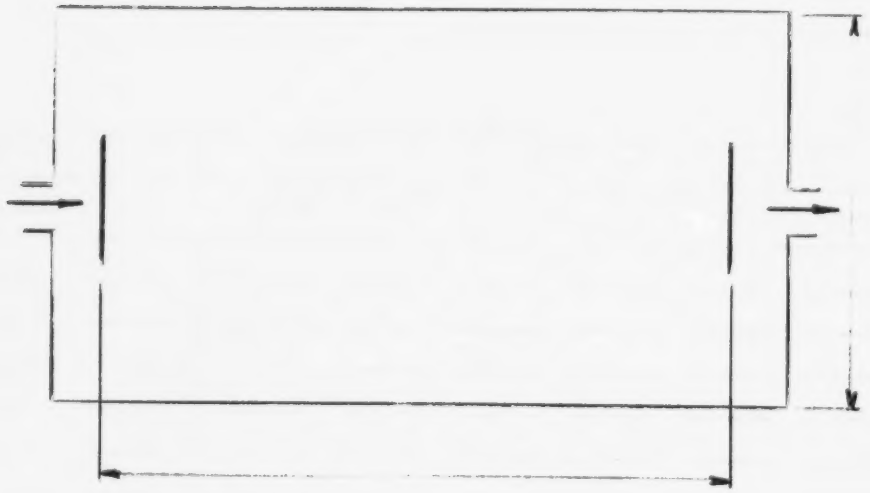
Ref. No.____

(26) Sketch of Tank (Add inside dimensions and details)

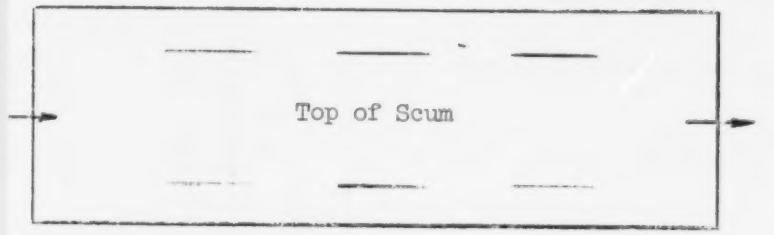
Elevation of Tank

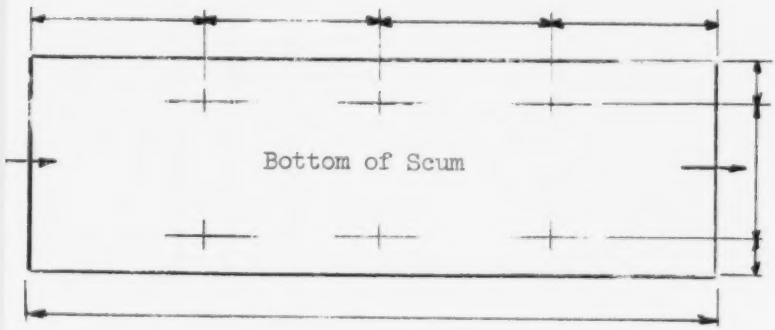


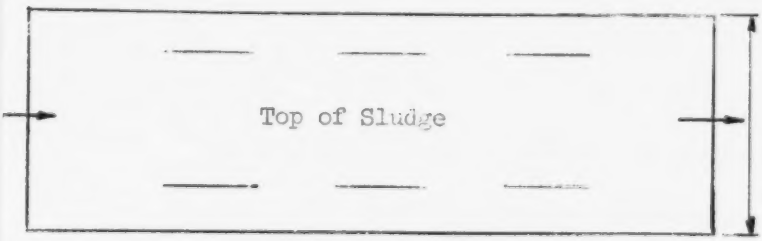
Plan View of Tank



(27) Scum and Sludge Measurements (Distance from top of tank wall)







Ref. No. _____

Compartment No. _____

Volumes:

Sludge _____ ft^3

Sub. Scum _____ ft^3

Float. Scum _____ ft^3

Total Scum _____ ft^3

Clear Space:

Scum _____ ft.

Sludge _____ ft.

Summary Table

Points	Scum						Sludge		
	Top	Bottom	W.L.	Float.	Sub.	Total	Top	Bottom	Depth
1									
2									
3									
4									
5									
6									
Avg.									

ABSORPTION SYSTEM MEASUREMENTS Pit_____ Trench_____ Bed_____

(28) Seepage Pits:

	A	B	C	D	E
G.S. to top dome					
G.S. to bottom dome					
G.S. to inlet invert					
G.S. to liquid level					
G.S. to bottom pit					
Diameter of pit					
Diameter of lining					
Type of lining					
Thickness of gravel					

(29) Trenches and/or Beds:

	A	B	C	D	E
G.S. to top gravel					
G.S. to top tile					
G.S. to bottom gravel					
G.S. to liquid level					
Width					
Rel. Elev. of G.S.					

(30) Calculated Values:

Seepage Pit:

Effective depth_____ft. Diameter_____ft. Depth of Ponding_____ft.

Area Provided: Bottom_____ft^2 Sidewall_____ft^2 Total_____ft^2

Area Wetted: Bottom_____ft^2 Sidewall_____ft^2 Total_____ft^2

Trenches or Beds:

Total length____ft. Avg. width____ft. Depth gravel____ft.

Depth of Ponding_____ft.

Area Provided: Bottom____ft^2 Sidewall____ft^2 Total____ft^2

Area Wetted: Bottom____ft^2 Sidewall____ft^2 Total____ft^2

(31) Summary:

A_T_____ft^2 P_____ t_____ $A_T/_P$_____ $A_T/_{Pt}$_____

(32) Condition of Absorption System

_____

_____

_____

_____

_____

_____

(33) Soil Type and Description

_____

_____

_____

_____

(34) Percolation Test Results (Attach data sheets and locate tests on sketch)

Hole No.	1	2	3	4	5	6	Avg.
Perc. Rate (In./Hr.)	____	____	____	____	____	____	____

Depth to water table_____ft. Depth to rock_____ft.

(35) Description of Pictures Taken

_____

_____

_____

_____

_____